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THE AGRICULTURE

OF THE

UNITED PROVINCES

AN INTRODUCTION FOR THE USE OF LANDHOLDERS AND OFFICIALS

BY

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SECOND EDITION

ALLAHABAD

Printed by F Luker Superintendent Government Press

1912

Price Rs 1 8 0]

Preface to the First Edition.

THE welfare of the cultivator may be affected for good or for evil by the actions of two distinct classes the officials with whom he has to deal and the landholders (or their subordinates) under whom he holds his land. The two classes have at least one feature in common, that they know very much less of the cultivator's business than he knows himself It is true that an observant man may in the course of time collect a mass of information on the subject, but the process is in any case slow, the power of independent observation is comparatively rare, and thus it happens that even experienced land agents and officials *may do a great deal of harm merely from* ignorance and thoughtlessness The present volume has been compiled with the object of supplying an introduction to the subject which may be of use to all who have to deal with the cultivator, not by saving them the trouble of observing for themselves, but by furnishing them, so to speak, with a framework on which they can arrange the knowledge they acquire

The book is divided into two parts the first aims at giving a general account of the subject, while the second gives some details concerning the different agricultural regions of the provinces, and the various crops that are grown. The method of description adopted in the opening chapters calls for a word of explanation Even in England it is not possible to assume that a well-educated man is familiar with the elementary principles of science which explain and justify the empirical art of agriculture and in India at the present day it is generally safe to assume that a knowledge of the principles of science is altogether wanting But it is not possible to give even an elementary view of agricultural practice without referring to such

subjects as the behaviour of water in soils, the collection and dissipation of nitrogen, and a few other fundamental matters and it has on the whole seemed the best course to begin the subject by a broad statement of principles, which will be truisms to a reader with scientific training but must be taken as axioms by those who have not enjoyed that benefit If the scientific reader finds that the principles have lost some of their completeness in the process the writer can only apologize for the defect, which indeed appears to be inherent to a greater or less extent in the treatment of the subject which has been adopted

In a work of this kind it would be pedantic not to use the vernacular terms which are current in every-day conversation I have used English names where they express clearly the nature of the thing or process to which they are applied, but in other cases I have preferred vernacular terms to cumbrous paraphrases A glossary will be found at the end of the volume

I have indicated in notes at the end of several chapters the books of which I have made most use, and which appear likely to assist readers who wish to pursue the subject further, but I must express my special obligations to Messrs Fuller and Duthie's monograph on the Field and Garden Crops of the Provinces I have also to acknowledge the cordial assistance I have received from my colleague Mr J M Hayman, and also from Mr S H Fremantle Indian Civil Service who has supplied me with much information on Bundelkhand affairs and has by his criticisms enabled me to improve the earlier chapters in numerous details

It is perhaps desirable to add that the views on matters of policy which appear in the chapter on the management and improvement of estates, are offered on my own responsibility and do not claim to represent the attitude of the Government under which I am privileged to serve

May 1904

Preface to the Second Edition.

A revision of this work is called for partly by the changes in the agriculture of the provinces during the last eight years, but mainly by the advance in knowledge that has resulted during that period from the work of the expanded department of agriculture. I am indebted for assistance in the work of revision to many officers, but particularly to Mr Burt and Dr Parr, the Deputy Directors of Agriculture

This edition is being issued as a Government publication and correspondence regarding its contents should be addressed to the Director of Land Records and Agriculture, United Provinces, Lucknow

July 1912

study of several branches of science, and readers who do not possess the requisite knowledge of physics, chemistry, and physiology must be content with a partial explanation The rest of this chapter aims at stating in plain terms a few of the principal conclusions that have been reached on this subject Proofs of these conclusions must be looked for elsewhere they can be stated here only as axioms on which to found an explanation of the cultivator s conduct and of his needs

What the cultivator does

In the first place then it is not strictly accurate to say that a man grows crops or makes crops grow Given certain conditions, plants grow of themselves whether man interferes or not if some of those conditions are wanting no amount of interference (short of actually supplying the defect) will make the plants grow The point is important for its clear comprehension enables us to see the part actually played by the cultivator Plants grow in their own way the cultivator intervenes to make the conditions of growth as favourable as possible for the attainment of the object he desires We have then to ascertain the conditions of growth and having done so to see how they can be affected by the action of the cultivator

Stages of development

In the development of ordinary farm plants there are three distinct stages which may be called *germination growth*, and *ripening* An ordinary seed can be kept for a long period without undergoing a material change, but when a cultivator sows seed in his field the great majority of the seeds are expected to yield plants the seed puts out a small shoot or shoots, and the beginnings of a root, and at the same time begins to shrink in size

Germination.

This is germination: what has happened is that the plant has begun to grow from the seed and to use up in its growth the material stored in the seed. A healthy seed requires for germination (1) a suitable temperature in the soil where the seed lies and (2) a certain amount of moisture in the soil, these conditions will not however induce germination in an unhealthy seed so that the choice and preservation of good seed are essential to success The ordinary operations of tillage and sowing are directed to secure suitable conditions of moisture and temperature, as will be explained later on but it may be noticed here that the soil as such is not a condition of germination we can make seeds germinate by placing them on a damp tile or in a damp piece of cloth and keeping them at a certain temperature

Growth

The second stage of development is marked by the increase in size of the plant, both in the surface growth and in the roots It is obvious that a maize seed (for instance) does not contain all the matter which goes to form the mature plant by far the greater portion of the plant has come from sources outside the seed, and the art of cultivation so far as this stage of development is concerned lies in putting the plant in a position to secure the matter which it needs The first requisite of the growing plant is stability, as plants do not grow satisfactorily in any but their natural position. Stability depends on the way in which the soil has been prepared the particles must be close enough together to support the plant through its roots, while not so close as to prevent the roots from growing This condition of the soil is influenced by the kind of tillage adopted.

Plant food.

The matter taken up by the plant can be conveniently described as "plant food," it feeds the plant just as a man is fed by the food that he consumes. There is however, a marked difference between the methods of feeding adopted by plants and by animals an animal takes in its food solely through the mouth, which also serves to supply most of the air it needs a plant takes in one kind of food through its leaves and green stalks, and other kinds along with water through its roots while it breathes air through a large part of its surface (including the roots)

Food from the air,

The substance taken in through the leaves is a gas contained in the air which is usually called carbonic acid gas This gas is produced by all animals when they breathe, by fuel when it burns and by animal and vegetable matter in decaying, and there is always enough of it in the air to supply plants with what they need The cultivator therefore need not take any measures to increase the supply of this gas The plant however, cannot utilise this gas under all conditions though it may be present in the atmosphere, the actual manner of its utilisation is still imperfectly understood but so much is known that it is consumed only in those parts of the plant which are coloured green and only under the influence of sunlight. The cultivator has therefore to see that his plants get a fair supply of sunlight, he cannot of course affect the weather conditions, but he can so arrange his plants that the light reaches all the green parts of them. When this is the case, the carbonic acid gas is transformed into other substances, which go to build up the plant These substances are very numerous and change into one another in ways that cannot be discussed here various forms of starch and sugar are perhaps the best known.

Water.

The substances taken up by the roots are first water, and secondly certain things dissolved in the water The soil is composed of small particles of matter, each of which is ordinarily enclosed by a thin invisible film of water, the particles of the soil are not packed tightly together but separated by spaces which usually contain air, though if there has been heavy rain or where drainage is markedly deficient, they may be more or less choked by water The roots pass through these spaces, and the minute hairs which can be seen growing out from them are in contact with the particles of soil and take up water from the films surrounding them This water passes through the plant, some of it is used in building up the substances into which, as has been explained above, the carbonic acid gas is transformed, the rest is evaporated from the leaves in the form of vapour and passes into the air More water drawn through the roots replaces what is used up or evaporated, and thus there is a stream of water travelling upwards from the roots to the leaves

This water with the substances dissolved in it constitutes the sap of the plant, the actual mechanism of its movements cannot be explained without a somewhat elaborate scientific discussion, but the movement is essential to the life of the plant. If the supply of water in the soil is insufficient, the effect is seen in the withering of the plant, and one of the main objects of tillage is to regulate the supply as far as possible

Minerals.

Almost the whole bulk of the green plant is composed of substances built up out of water and carbonic acid gas, the former taken up by the roots and the latter by the leaves But the plant cannot live on these substances alone, it requires in addition small quantities of various

other substances, which it obtains from the soil, and though the quantity required is so small, any deficiency in the supply has a most injurious effect on the plant * The most important needs are substances which bear the names of (1) *potash*, (2) *phosphoric acid* (3) *nitrates*, lime, iron and sulphur are also required, but the supply of these latter substances in the soils with which we are concerned is in practice never found to be deficient, and we need not consider them further As regards the other three, it may be said broadly that potash and phosphoric acid are obtained from the mineral contents of the soil, and nitrates from other sources which will be described later

As has been said above, the soil is composed of small particles packed more or less loosely together some of these consist of vegetable matter in a state of decay, but the bulk of the soil is *mineral*, that is, it consists of fragments of rocks which have gradually been broken up, and either overlie the rocks from which they have been formed, or have been carried by water (and to a less extent by wind), and dropped in a position more or less distant from the source Thus the soil of the duab has been gradually deposited by the rivers flowing from the Himalayas, and consists of fragments of the rocks which form those mountains, while most of the very distinct Bundelkhand soils have been similarly produced from the mountains of Central India. The thin soils of the plateaux seen in Bundelkhand have on the other hand been formed where they lie

Rocks are composed of a large number of substances and differ materially in composition the commonest substance is what we know as sand which makes up 70 to 90 per cent of the total weight of soil In the rocks much of this sand is combined with other substances, among

* The effect of very small quantities of certain substances is not an isolated phenomenon we see something of the same kind in the need experienced by human beings for small quantities of salt

which are potash and phosphoric acid, and it is from these complex minerals that the plants derive their mineral food. But it is important to notice that these complex minerals are not as a rule soluble in water a stone placed in water does not dissolve in the same way as a piece of salt and as long as the minerals are not dissolved in water the plant cannot make use of them It is however, found that these complex minerals do not remain permanently unchanged in the soil but that small particles of them when exposed to air and water gradually decompose and leave the potash and phosphoric acid in a soluble form. The particles of the soil are as has been said above, surrounded by a thin film of water and any soluble substances forming on their surfaces are at once dissolved in this Thus, as the potash or phosphoric acid is set free from the complex mineral containing it, it passes at once into the soil water, and becomes available for the plant The mineral matter of the soil may thus be regarded as a store of these substances, gradually yielding them up in small amounts The cultivator can to some extent increase the rate at which this process is carried on by "breaking up" the soil as it is called thus quickening the decomposition of the complex minerals But it is not to be supposed that all soils are alike either in the amounts of these minerals which they contain or in the rate at which they yield the desired substances. In many parts of the world soils do not contain sufficient soluble potash or phosphoric acid to give good crops, and the natural supply must be supplemented by special manures these may also be necessary when it is desired to get exceptionally large crops off ordinary soil In such cases, if the soil is deficient in the supply of phosphoric acid, it is usual to apply bone-dust, superphosphate or some similar manure containing what is required, while if potash is in defect, saltpetre, kainit or some other mineral containing potash is added. As a general rule, however

the soils of these provinces when carefully cultivated yield as much potash and phosphoric acid as is required by ordinary crops, and the application of such special manures is unnecessary, while their cost under present conditions is prohibitive Saltpetre, however, is occasionally used, as will be seen in the chapter on manures

Nitrates.

Finally we have to consider the supply of nitrates, the most important matter of all so far as these provinces are concerned The substances known as nitrates consist essentially of nitrogen in combination with various other substances Now, nitrogen is a very common gas, making up about fourth fifths of the air, but *combined* nitrogen is by no means so common The distinction indicated by the use of the word *combined* will be familiar to readers who have studied chemistry it cannot be explained without some knowledge of that science, but it may be illustrated in various ways Thus ordinary sugar may be regarded as a combination of charcoal and water , that is to say, it is possible to take 23 parts of sugar and separate it into 12 parts of charcoal and 11 parts of water but you cannot make sugar merely by mixing these substances together in these proportions Or, again, if you mix sand with common washing soda, you can still recognize the two substances in the mixture , but if you beat the mixture strongly, the two substances disappear and glass is formed in their place that is, they are now combined to form a new substance * Now the enormous quantity of nitrogen contained in the air is as such of no use to ordinary plants, but combined nitrogen in the form of nitrates is absolutely essential to their growth that is to say, plants cannot use the nitrogen in the air as they use the carbonic acid gas , it must first

* The process is in reality not quite so simple as stated in the text for purposes of illustration

enter into the state known as combination Unfortunately for the cultivator, this is very difficult so far as is known nitrogen enters into combination only in two ways that can benefit him. The first way is under the influence of electricity, and as a matter of fact a certain amount of combined nitrogen is formed in the air during thunderstorms, and is brought on to the earth in rain The quantity so obtained is very small, it is not negligible but is quite insufficient to replace what a crop takes off the land. The second source of combined nitrogen is found among some very minute living beings, which inhabit the soil in enormous numbers some of these beings, which can be seen only with a powerful microscope, will under certain circumstances feed on the nitrogen of the air, and produce combined nitrogen from it, and though each individual is so small, the enormous number present in the soil make this source of supply most important

Now the individual cultivator obviously cannot employ electricity to produce combined nitrogen. In recent years an industry of this sort has been established in various countries, and the substances named cyanamide and calcium nitrate which are produced, are of high value as fertilisers, but the industry has not yet reached India, and the cost of importing these substances renders their general use here unprofitable

The cultivator can however do much to aid the growth of the minute beings which we may speak of as bacteria Two main classes of bacteria have to be encourged. One class, though existing in the soil, can thrive and multiply only among the roots of certain kinds of plants belonging to what botanists call the leguminous order this group includes plants such as gram, peas arhar, urd, hemp, and other crops, as well as certain trees and weeds, so that the cultivator can get a supply of combined nitrogen by growing these crops If you carefully dig up a growing gram

or arhar plant and wash the roots free from earth, you will find them to bear small knots or lumps · these knots or lumps, which are known as nodules, are the homes of the bacteria in question, and where they are found they indicate that the soil is being enriched in combined nitrogen. The second class of bacteria is not dependent on particular plants, but lives freely in the soil They are known to exist in India, but they have as yet been little studied in the country, and their relative importance has not been ascertained.

These two sources are, so far as is known, the only ways in which fresh supplies of combined nitrogen are obtained from the nitrogen of the air, though it is possible that other agencies may be at work which have not yet been discovered. But in addition to the fresh supplies of combined nitrogen from these sources there is a very large stock in existence, much of which is used over and over again the circulation of this stock is a matter of the greatest practical interest What we have spoken of as combined nitrogen is really a large group of substances having the common feature that they contain nitrogen in combination To give a list of these substances would be to enumerate perhaps the majority of familiar objects combined nitrogen is contained in flesh, in flour and in milk, in skin and bone, in dung and urine, in wood and coal, and so on Yet other forms are what we know as smelling salts as saltpetre, &c, &c Now, if we consider together all the nitrogenous substances obtained from animals and plants, we see that they are used up in one of three ways they may be eaten by animals, they may be burnt, or they may rot If eaten by animals the nitrogen remains combined, and eventually it will either be burnt or rot In burning, the combined nitrogen is destroyed and the nitrogen returns to the air in its original condition, hence every time that any nitrogenous substance is burnt, there is a potential loss to

agriculture The loss is least when the fuel consists of substances such as coal or wood, which contain proportionately little nitrogen, it is greatest when the substance is rich in nitrogen. The commonest loss in these provinces is from the use of dung as fuel it is unavoidable under present conditions, as fuel is a necessity of life, and wood or coal are not as a rule available for ordinary people, but the *fact of loss should be clearly recognised* The *process* of decay is that which interests the farmer most closely, most of the substances we have enumerated contain the nitrogen in a state which plants cannot use, but when they are left alone in moist air, they are at once attacked by various bacteria which live on these substances, and which are present practically everywhere These bacteria are of different kinds, and the results of their work are accordingly different * Some give off *free* nitrogen they are of course hurtful to the farmer, just as if the substance was burnt Some give off a substance known as ammonia, it has a well known pungent smell which can usually be recognised about manure heaps, cattle-sheds, and the like Some of this passes into the air, and is temporarily lost, but may eventually return to the land with the rain the rest is attacked by yet other species of bacteria, which at length convert it into the forms known as *nitrates* (saltpetre is the commonest of these), which are soluble in water and can be used by the plant The plant takes up the nitrates in the water and uses them to build up other substances, and so the circulation goes on.

This subject is of such vital importance that it may be further illustrated. Suppose a crop of wheat has taken up

* The harmful bacteria as a rule thrive where there is little air, while the beneficent ones require a free supply hence the latter are in a favourable position when the soil is well tilled and drained, while the former can do the greatest amount of harm in a badly tilled waterlogged soil.

20 lbs of nitrates Perhaps 18 lbs of these will be worked up into substances stored in the grain, a pound will remain in the straw, and a pound in the roots The roots will decay in the field, that is, the one pound of nitrate returns to the field as combined nitrogen, to be worked up again by the bacteria of the soil The straw will be eaten by cattle and the combined nitrogen in it will either go to form flesh, milk or hair or will pass out in urine or dung The dung may be burnt if so, the combined nitrogen is lost, or it may go to the manure heap where it decays, and the combined nitrogen (or some of it) is worked up again into nitrate for the land. When the cattle die, probably the flesh and hair will be allowed to decay and their nitrogen similarly worked up into nitrates The milk will be consumed by other animals and the nitrogen in it disposed of in the same way as that contained in the straw Finally the grain also will be consumed and the nitrogen in it will either be lost or will return to the land in the manner just indicated there being in this respect no difference between the functions of human beings and those of animals

The practical lessons to be learnt from these considerations are as follows —

In the first place, no product of animal or vegetable life should be burnt if it can be left to decay without risk of injury to health in the second place, the decay should be so regulated as to lose as little nitrogen as possible, and in the third, care should be taken that the products of decay reach the soil, and are not carried away into the rivers

The action to be taken by the cultivator will be considered in the chapters on tillage and manuring, but a word may be said here regarding the attitude in which the whole question should be regarded. At one time it was usual to place combined nitrogen on the same footing as potash and phosphoric acid, and to say that if there was a deficiency

t should be made good by putting fertilisers on the land and this attitude is still common in popular literature But the more modern tendency is to consider, not the stock of combined nitrogen available in the soil at a given moment, hut rather the rate of its production in the soil, and the arts of tillage and manuring are now regarded as directed in great part to the maintenance of the most favourable conditions for the development of bacteria of the right classes

Respiration.

So much may be said regarding the food taken up by the plant in addition it requires air which in ordinary plants is breathed through minute openings in the surface both of the roots and of the upper growth For the latter no precaution is necessary, but it is most important to see that air has free access to the roots If the soil is caked into large masses, or if the spaces between the soil particles are choked by water, the access of air will be hindered, here again thorough tillage is necessary, while if there is risk of waterlogging, drainage may also may be required A special class of plants, however is adapted to life in water or waterlogged soil, having arrangements (which cannot be described here) for the supply of air in other ways Sing hara belongs to this class of plants, but the most important is rice The modifications in ordinary tillage required for growing rice will be mentioned in the section dealing with that crop

Ripening.

The final period in the development of an ordinary plant is occupied by the ripening of the seed or fruit. First the plant flowers, and the flowers develop into seed or fruit, the leaves at the same time tend to lose their green colour and turn yellow or brown A flower may be either a bright, conspicuous object as in peas or flax, or it may be

small and inconspicuous as in wheat or juar, but in all cases two elements, the male and the female, must combine to form a perfect seed The male element can usually be seen as yellowish dust (known as pollen), while the female element is not visible in an ordinary flower but is contained in a receptacle which can be seen as a rule at the base of the flower In order that seed or fruit may be formed the pollen must reach this receptacle, and this is accomplished in a great variety of ways, of which we can here give only a few instances The simplest case is where both the male and the female elements grow in one flower and pollen falls direct on to the female receptacle This is usually the case with wheat and some other cereals If we open one of the small flowers on a newly-formed ear of wheat we find inside it three upright yellow spikes and a white, feather like thing at the base The spikes are bags containing the pollen, while the feather like thing is the receptacle if the flower is opened early on a bright morning, we can often see the pollen bags burst open and the yellow powder contained in them fall on to the receptacle Once there it penetrates inside, and so fertilises the flower Another type of fertilisation is found in maize , here the male and female elements grow on different parts of the plants the "spike" at the top contains the pollen, while the receptacle is indicated by the tuft of hairs which grows out in one or more places on the stem In this case the pollen gets into the air, and thence falls on to the receptacle, so that as a rule each plant is fertilised by the pollen of some other plant, while in wheat each flower fertilises itself In other plants, again, the male and female elements are in the same flower, but fertilisation is usually effected by insects, which carry the pollen from one flower and place it on the receptacle of the next of course they do not do this intentionally, but the shape of the flower is such that when the insects enter it for the sake of the honey or nectar

it contains, the pollen falls on their bodies, and is then brushed off when they visit another plant. Plants may therefore be divided into two classes according to the methods of fertilisation, the first case given is described as self fertilisation, while the others are spoken of as cross fertilisation, and the transfer of pollen from one plant to another is known as crossing

The cultivator cannot interfere with advantage in the fertilisation of ordinary plants, though in some parts of the world he has actually to arrange for the fertilisation of flowers of certain fruits, such as dates, but the subject is of practical importance in that any hindrance to fertilisation will have an injurious effect on the crop. Heavy rain, for instance, just when maize is flowering, will wash much of the pollen off the plants and out of the air, and some of the plants will be imperfectly fertilised in this case the plants will look healthy enough, but the cobs will develop imperfectly and the quantity of seed produced will be lessened Such injury is likely to be greatest where the flowers are open, and least in crops such as wheat, where fertilisation takes place within the closed flower

The method of fertilisation is of practical importance in relation to the introduction of superior varieties of crops Where the plant is self fertilised, the new variety can easily be established in any locality to which it is suited, but where cross fertilisation is the rule, a small area of the new variety grown near the existing variety will be largely fertilised by the latter's pollen, and the produce of the seed so formed will not be that of the new variety but a mixture of very irregular composition Hence it is almost useless to grow a few small plots of a new variety of a crop like maize in villages where the crop already exists if a new variety of maize is to be introduced, organised action is required over a considerable area to secure

that only the new variety is sown within its limits so that crossing with the old variety shall be impossible

Contents of seeds.

After fertilisation the seed or fruit gradually develops within the flower A seed must contain first the germ or living element which will under proper conditions start the growth of a new plant, and secondly enough food for the germ to live on until it has sent out roots and begun to collect food for itself This food is produced in the parent plant from the materials that it has collected from the soil or the air, and passes into the developing seed large numbers of different substances are stored in this way by different plants, but they can be grouped in two main classes according as they do or do not contain combined nitrogen We shall see further on the importance of these two classes of substances in animal nutrition, here we will merely say that the non nitrogenous matter is usually either *starch* or *oil*, while the nitrogenous matter is in various forms which are known collectively as *albuminoids* or *proteids*

Various products of plants

It is usually at this point that man steps in and takes for his own use the substances which have been stored for the growth of the next generation of plants Seeds such as wheat or maize containing starch and proteids, are used for human food while seeds such as linseed which contain comparatively small amounts of starch but much oil, are made to give up the latter substance In a few cases seeds are used not for their store of food but for some accessory

The commonest of these is cotton just as many grass seeds have long feathery processes attached to them to enable them to be carried about by the wind, so the seed of the cotton plant is covered with woolly fibres, and it is mainly for the sake of these that the plant is cultivated,

The poppy again forms in its seed-capsule a particular kind of drug, which is extracted as crude opium

Whatever may be the products for which the plant is grown, it is a general fact that the quantity stored depends on the health of the plant Wheat grown in land which contains insufficient plant food, or an inadequate supply of water, will yield small thin seed and also a small number of seeds to each plant The weight of seed obtained from an acre will therefore be much less than in the case of a properly nourished crop A starved poppy crop again, will give a small yield of opium, a starved linseed crop, a small yield of oil, a starved cotton crop, a small yield of fibre And not only will the yield be smaller but the quality of the yield will commonly be altered, the composition of the grain may vary considerably according to the conditions under which it has been grown

Special types of crops.

The account which has been given above of the development of a plant applies in its entirety only to those plants which are known as annuals, that is to say, those which produce their seed at the end of the first season's growth and thereafter ordinarily wither and die, or at least do not produce a second yield of seed This is the case with the great majority of farm plants such as wheat, rice, barley, the various millets, and the pulses In some cases, however, the cultivator does not wait for the ripening stage, but cuts the plants during growth this is done with juar grown for fodder, and occasionally with other plants grown for the same purpose, with tobacco, which is grown for the leaves, and with some green vegetables or salads Further there is a type of plant which only yields its seed in the second season of growth During the first season these plants grow in the ordinary way, but instead of forming seeds they store up the food which they have gathered in a form in which it will remain available during the second

season the plant then ceases to collect fresh food, and lives on what it has stored up until its seed is matured In this case the cultivator's object is to facilitate the storage of as much food as possible, and then at the end of the first season take the store for his own use The store is usually formed underground in the roots or the lower part of the stem as with radishes and turnips the amount of storage depends mainly on the facilities which the plant has for collecting food, and consequently the principles of cultivation are generally similar to those already indicated for annual crops

The case of the sugarcane is somewhat exceptional, as the plant can live for several years this plant during the season of growth stores up food in the form of sugar, which it consumes later on here the food is stored not in the roots but in the canes The cultivator prefers to cut it at the end of the first season and extract the sugar so stored

There is further a large class of plants known as "perennial," which yield seed or fruit year by year for periods of varying length, the plant continuing to live on Trees come under this class and the cultivator is mainly concerned with fruit trees such as the mango, the guava, &c. The special features of the growth of these perennials will be dealt with in the chapter on tree planting

Summary.

From the account which has now been given of the growth of plants it will be seen that the cultivator has many points to attend to the principal needs and the methods by which they are attained are summarized in the following table —

Needs of the plant	Operations to meet these needs
1 Good seed	Choice and preservation of seed
2 A suitable seed bed	Tillage occasionally irrigation

	Needs of the plant.	Operations to meet these needs
3	Support for the plant .	Tillage
4	Room for development ..	(1) Method of sowing (2) weeding
5	Supply of water	Directly—irrigation or drainage. Indirectly—tillage and manuring
6	Mineral food	(1) Tillage, (2) manuring (3) rotation of crops
7	Combined nitrogen	
8	Air for the roots	Tillage and drainage

It will be seen then that the tillage of the soil may affect almost all the conditions of development this is the most important part of the cultivator's work, and will be considered before the more special operations of sowing, weeding, irrigation, manuring and selection of suitable crops in rotation But when the cultivator has done all he can, the weather still exercises a controlling influence on the success or failure of his efforts we will therefore begin our description of the agriculture of the provinces by a short statement of the type of weather that may be expected and of the effect that unseasonable weather may produce

Notes to Chapter I

(a) The following figures will help to give an idea of the extent to which mature plants consist of the different things they have taken up but it must be remembered that water is constantly being given off by the plant, and therefore the amount of water it has used is far more than what remains in it at maturity A crop of wheat which I saw growing gave about 2,000 lbs. of grain and 3 000 lbs of straw (*bhusa*) to the acre The total weight of the crop removed from the land was thus about 5 000 lbs Out of this about 600 lbs was water, 1 200 lbs woody fibre of little use for food, and over 300 lbs miscellaneous substances (including a little oil) The things really useful as food were starch (and substances of the same kind) 2,000 lbs albuminoids (*i e* nitrogenous matter) 300 lbs., and minerals about 350 lbs. Two-thirds of the starch and albuminoids were in the grain and

phosphoric acid will be very much the same as in the clay, and that of nitrogen very little greater, very rarely as much as ½ lb in all

It is noticeable that while an ordinary bhur soil may contain 750 lbs of sand out of a total weight of 800 lbs, even a stiff clay contains as much as 600 lbs, or three-quarters of its whole weight. It is thus easy to see why the size of the soil particles is of such great importance as even the heaviest clay is three-quarters sand

(b) The reader who desires to study further the subject of plant growth will find a very complete introduction in *Agricultural Botany*, by John Percival (London Duckworth & Co) A thorough recent treatment of the subject will be found in *Vegetable Physiology* by Professor Reynolds Green (London J and H Churchill)

Chapter II—THE WEATHER

Introductory.

The ordinary type of weather in the provinces is so well known that a brief description will suffice Rain sets in about the end of June, and from then till nearly the end of September the air is full of moisture, and rain occurs on the average about once in three days As a rule, the rain comes in bursts there will be heavy rain for two or three days together, and then an interval of finer weather The actual amount of rain received in this period varies with the locality it is largest in the districts lying under the Himalayas, and among these it is greater towards the east Further south the rain diminishes from east to west and also from the north to the line of the Jumna river The smallest rainfall is received in a strip of country of varying width lying along this river and extending roughly from Aligarh and Muttra to the south of the Fatehpur district. further south in the Bundelkhand districts the rain is usually heavier The weather clears towards the end of September, first in the western districts and then gradually eastwards once the skies have cleared the temperature falls rapidly until January Light rain is often, but not always,

received between December and February, and after the latter month the weather rapidly becomes warmer, and no more rain can be expected till June except in the way of thunderstorms

Seasons.

The year is naturally divided into two seasons the kharif and the rabi The former begins in June or July, the latter in O tober In the former are grown those crops which need a high temperature and a large supply of water, in the latter those that require cooler weather and a moder ate supply of moisture The kharif season usually opens earliest in the east and extends up country as the monsoon current progresses The harvest matures earliest in the west and latest in the east The season for sowing rabi begins earliest in the west from which the monsoon cur rents first withdraw the rabi harvest on the other hand begins earliest in the east

Distribution of rainfall

Perhaps the mistake most commonly made in estimating the character of the season is to judge by the total amount of rainfall without considering its distribution in point of time the distribution is usually the more important con sidera ion of the two The following may be taken as an ideal distribution in those parts of the provinces where rice is not largely grown To begin with, there should be some rain at the end of May or the beginning of June so that ploughing can be started as soon as possible Next, heavier rain is wanted later in June to get the land thoroughly wet fo lowed by a period of fine weather for tillage and sowing The rest of July and August should be marked by o casional heavy falls with bright intervals between but no interv l should last longer than a week or ten days Simi lar weather with rather less rain is wanted in September, but towards the end of this month there should be one

or two falls of rain to get the land ready for rabi operations Where late rice is largely grown this distribution should be somewhat modified on the whole, more rain and less sunshine are wanted, there should be at least one very heavy fall of rain towards the end of July, and the following month should be wet, while a final fall in the early part of October is most desirable

So much for the kharif season For the rabi the first requirement, assuming that the September rains have left sufficient moisture in the soil, is that the air should cool down rapidly so that the soil may fall to the proper temperature for germination. This cooling occurs most rapidly when the wind is moving steadily from the west and the nights are free from cloud. During November and the early part of December the weather should remain clear and get steadily colder but soon after the middle of December a light fall of rain is beneficial A second fall is desirable in the first half of January after which the eastern half of the provinces will want no more rain, while a further light fall in February will benefit the western districts It is of the utmost importance that the cold weather rain should not extend over a long period, but that the showers should be followed promptly by clear weather a continuance of damp cloudy weather in January and February is almost sure to have a disastrous effect by promoting the spread of various plant diseases The rest of the season should be dry, and (especially) free from hailstorms the west wind must be expected to blow strongly during March, but it is an additional advantage if its strength is moderate As soon as the rabi crops are threshed and stored, rain will do great good, benefiting the young sugarcane and other standing crops and enabling the cultivator to start his ploughing for the next year

A year of the type sketched above will enable the cultivator to till his soil to the best advantage and to obtain on

the whole good crops: the reasons why certain kinds of weather are important at particular times will appear in later chapters, for the present the statements which have been made must be accepted as based on experience It must be remembered too that there is usually some conflict of interest between different crops and also between individual cultivators Thus, late rice may be enormously benefited after a dry season by a fall of rain late in October, which may at the same time have disastrous effects on the rabi whether such a fall is a benefit or the reverse in any locality depends on the relative importance of late rice, and relative importance may in ordinary cases be measured roughly by the area under the crop Or again, when rain falls in the middle of December it will be of great benefit to crops which have not been irrigated, but may even do harm in fields which have been irrigated a few days before. Thus, whatever may happen, you will always find individual cultivators ready to grumble and usually with good grounds what benefits the locality as a whole may cause loss to individuals, while, on the other hand, individuals may derive benefit from the calamities of their neighbours Such considerations are often of great importance in connection with the realisation of rent and revenue

Effect of abnormal weather.

An endeavour should be made to foresee the probable effects of abnormal weather the remarks which follow summarize the experience that has been gained on this subject Dealing first with the kharif season, there is the case when no rain falls between June and September This actually occurred in 1877 over some parts of the provinces In this case it may be possible to bring a few fields to maturity by the aid of irrigation, but the heat is likely to be so great that the ground will dry very quickly a field will need three or four times the amount of water that would be required in the cold weather,

and it will have to be irrigated very much oftener so that as a fact the bulk of the Kharif will not be sown at all or, if showers at the beginning of the season have led the cultivators to sow, the crops will be lost In this case there will be a famine* unless the people have adequate resources in reserve and in any case there will be a fodder famine

Next there is the case where the rains begin late, but once started are fairly copious It is not possible to state from experience the latest date of rain beginning which is consistent with a moderately good Kharif crop, but we know that if the rains have started by the middle of August and are fairly copious thereafter, enough food and fodder can be grown to keep the people and cattle going until the rabi is harvested. The area sown, especially of the earliest crops, will probably fall short and the outturn generally will not be up to the standard, individual cultivators will be found who have got practically nothing, and some localities may suffer much more than others

Next there is the case where the rains cease prematurely The season of 1896 is a good example of this up to the third week of August in that year the rains were normal, but from date they ceased altogether The earlier crops (maize for instance) ripened well enough in most places, but the later crops were generally failures. They were, however, available for fodder, and there was no fodder famine in this season though there was acute unemployment over a large part of the provinces It must,

* The term 'famine' has acquired a new meaning in the last half century Strictly speaking it indicates a condition where the food supply is insufficient to feed the people and this condition was formerly common The development of the railways and of trade has made an actual want of food a most improbable contingency and the condition which is officially described as famine is primarily one of acute unemployment among labourers owing to the cessation of field work

however, always be borne in mind that the drought of 1896 was the climax of a succession of misfortunes, and that its effects would in all probability have been much less serious if the previous seasons had been fairly prosperous The experience of this season then shows that good rains up to August will not secure the kharif, experience also shows that one heavy fall of rain in September will save the crops in such seasons, though the outturn will be reduced, and there is likely to be a serious loss of the rice crop

Next we may take the case of prolonged intervals of fine weather An interval of ten days without appreciable rain need hardly ever cause anxiety, and ordinarily the crops can stand a break of three weeks without serious injury anything over this period is likely to cause loss The facts of a break, however, depend largely on two circumstances first on the amount of moisture in the soil, and secondly on the character of the wind If the soil is at the outset very wet after a spell of heavy rain, a long break will do much less damage than if the soil were dry while a dry wind (usually westerly) will deprive the soil of its moisture far more quickly than when there is a damp east wind or a calm Sunshine again dries the soil more quickly than cloudy weather These considerations make it impossible to lay down hard and fast standards of the variations in weather that are sufficient to cause injury in addition it must be remembered that some crops suffer from drought much more than others It will never therefore be safe to assume that no damage has resulted from a break lasting only a fortnight, nor, on the other hand, can it be assumed that serious damage has been caused by a break lasting for three weeks, the whole character of the season, and the nature of the crops, must be taken into account

So far then we have considered abnormalities due to deficient rain Rain may be in considerable excess without

causing serious or general injury especially in the middle of the season Excess is most injurious when occurring (1) just after sowing, (2) when the crops are flowering In the first case the excessive moisture may cause the seed to rot or to develop weakly, and it may be necessary to resow the land in the second case the proper formation of the seed may be prevented and the outturn consequently reduced. In addition low lying land from which the water cannot escape will suffer from excess of rain, as the soil becomes waterlogged and the access of air to the roots is for the time being cut off Particular crops too are liable to injury from excessive rainfall at critical periods of growth, cotton for example suffers severely from heavy rain in September or October

The most serious danger to the rabi crops is that the soil may be too dry for sowing, as the result of a dry and hot September In this case only those fields can be sown which can be irrigated, and though the cultivators will make every effort to get as large an area sown as possible, there will be a serious shortage which cannot be made up by subsequent favourable weather Further some of the fields sown will get a bad start and sowing will be delayed by the need for irrigation before ploughing If in such a season no rain falls these late sown crops will suffer, while the supply of labour and of water may be insufficient to keep all the crops alive

If the ground has been sufficiently moist at seed time, and no rain falls during the cold weather, there need be no anxiety for the harvest as a whole, since the area commanded by irrigation is reasonably safe The dry crops must in this case suffer and may even be an entire loss in the drier soils, hence upland sandy villages and the unirrigated tracts of light soil south of the Jumna will be the greatest sufferers

The risk from excessive rain is much greater than is

if it occurs when the cereals are flowering, that is about the end of January in the centre of the provinces and somewhat later in the north and west. Such a frost may also damage the sugarcane reserved for planting, and thus reduce the cane area to be harvested in the following year.

Hail may occur at any time from December to April: it does as a rule little damage early in the season but when the plants have flowered and are forming seed, great injury can be caused by the flowers and immature grains being bruised and destroyed, and by the ears being severed from the plants. Fortunately, the area affected by a hailstorm is almost always small, and within this area its effect varies enormously: one field may be seriously injured while others a few yards away may escape almost untouched.

It will be noticed that the causes of injury which we have discussed in this chapter are beyond the control of man: no method is known of regulating the rainfall or controlling the occurrence of frost or hail.* Consequently the system of agriculture has been so developed as, where possible, to minimise the inevitable risks: and where this is not possible, as in the case of hail, the risks must be accepted as part of the cultivator's business.

Note to Chapter II.

The best description of the weather is to be found in *The Climates and Weather of India, Ceylon and Burma*, by H. F. Blandford (London Macmillan). For detailed accounts of the effect of abnormal weather on agriculture, it is necessary to consult the reports of the various Famine Commissions.

* A system intended to prevent hailstorms is carried out in parts of Europe, the means adopted being to fire charges of explosives, which are believed to produce sufficient disturbance in the air to prevent the formation of hail. The success of this system has been denied by the experts who investigated it, in any case there is more chance of it succeeding among the narrow valleys where it originated than on open plains.

Chapter III—THE SOILS OF THE PROVINCES

Introductory

The soils of the provinces fall into two main classes depending on their origin On the south of the Jumna most of the soils have been formed from fragments of rock brought down from the hills of Central India and they are very different from those of the rest of the provinces which are derived from the Himalayas We shall consider here the latter class under the name of duab soils the Bundelkhand soils will be dealt with in a separate chapter

Obvious differences in soils

No one can fail to notice the superficial differences in the duab soils In some places may be seen an uneven surface of loose sand which shifts under the influence of a strong wind in others the land is a hard, bare plain of closely packed grey or brown earth These two types are extremes and neither is culturable at a profit under ordinary circumstances the first is usually known as bhur with the addition of some uncomplimentary epithet (*e g uran yi* a word which indicates that the soil can be blown away by the wind) the second is most commonly termed usar The ordinary cultivated soils lie between these extremes Closely allied to the bhur is the sandy cultivated land which usually bears the same name closely allied to the usar is the inferior clay which grows only rice and is known variously as jhabar dhankar or matiyar and intermediate between these lies the great bulk of the cultivated land the loam known as dumat or doars

This classification of soils which is recognised by the cultivator in most if not all of the duab is based on real differences in nature and is therefore properly described as a natural classification of soils Further on we shall have to notice another system of classification which places

the fields according to their position with regard to the village site

Formation of soils.

The natural classification depends on *the average size of* the soil particles, a subject which we must consider at some little length If we look at one of the hill streams shortly after heavy rain, we can see that the water contains a good many fragments of rock which it is gradually carrying downwards. The largest of these fragments may be stones of considerable size, while the smallest will be mere dust which can be seen only by the cloudiness it produces in the water between these two limits fragments of all sizes will be found

If we follow the stream to a point where its speed is checked, probably at a pool, we find further that much of the solid matter is deposited at the bottom of the pool, and that it is deposited in order of size, the largest stones at the point where the speed is first checked, the gravel a little further on, then the coarse sand whether the finer sand and the dust are deposited depends on whether the flow of water is absolutely stopped or whether it continues at a reduced speed We thus see that the size of the particles which can be carried by water depends on the speed the greater the speed the larger the particles Thus, if we charge a stream of water with fragments of various sizes and then check the speed the water will sort out the fragments and deposit them roughly in order of size It is this sorting action of running water which is mainly accountable for the differences in the duab soils

Let us now turn from the hill stream to the Ganges khadir somewhere in the centre of the provinces and see what happens there We will find no stones or gravel, as the speed of the river *is not great enough to carry these* materials and they have all been dropped soon after the river has left the hills But we see that the water is muddy, that is, it is still carrying solid matter, and if we put some of the water in a bottle, this solid matter will sink to

the bottom Again we find that the river when in flood has been depositing solid matter in different places in one place it has covered good fields with some inches depth of coarse sand in another it has left a layer of fine mud on top of sand deposited in previous years Again, if we look at a place where the shrub known as jhau has sprung up in the sand we can see that fine mud has been dropped on the up-stream side of many of the plants, while there is much less or none at all on the down-stream side All these phenomena are illustrations of the sorting action of the water The river when in flood has carried large quantities of materials of all sizes from coarse sand to fine dust where the flood water has spread out over a wide stretch of land its speed has decreased and the coarser sand has been dropped (thus perhaps ruining what was fertile soil) further on where the speed has decreased further, the finer mud has been deposited So when water is flowing round the stems of the jhau its speed is checked at each plant and a little of the finer mud dropped there

Now, there are strong reasons to believe that what we see going on in the khadir on a comparatively small scale went on formerly over the whole of the duab, and that in fact the land of the duab has been built up by this means, in other words, the duab was once all khadir with the rivers flowing over it in undefined and shifting channels Where the flow of the water was only slightly checked, we have the bhur * where there were back waters

* The continuous stretches of sand along both banks of the valleys of the larger rivers form a striking feature of the physiography of the provinces In some of the older Settlement Reports their formation is ascribed to the gradual washing out of the finer particles of soil by erosion and drainage and the piling up of the sand by the action of the prevailing winds This theory appears to be inadequate, and it is more probable that when geological changes caused the rivers to begin to curve out the wide valleys which we know as khadir, they gradually settled in the stretches of sand where channels could be easily cut, and abandoned the clay tracts where the surface is much more resistant The abandoned channels in the clay tracts are now represented by the chains of jhils so often found parallel with the existing rivers, but outside their valleys

and pools we have the usar, and elsewhere we have the cultivable soils made up of particles of intermediate size And just as we now see sand deposited on loam and mud on sand so in times past changes in the direction and speed of the flow have resulted in layers of sand above clay and clay above sand such as we find whenever we look at an excavation in the ground. We can also understand why on the whole the soil is more sandy near the hills and more clayey further off Of course there is clay in the Meerut division and there is sand in Benares but, on the whole the south eastern soils are heavier than the north western, since most of the larger particles tend to be deposited at the places where the speed is first checked

Materials of the soil

The coarsest particles deposited by water in the plains are mainly composed of the substance named silica, and are ordinarily spoken of as sand The smaller particles which are described as silt or clay contain compounds of silica with alumina iron potash soda and other substances these compounds being named silicates Of these the silicates of alumina predominate and they form the principal constituents of clay

Lime is another substance which is found in almost all soils It is of great importance in cultivation as its presence is apparently necessary for the health of the nitrate-making bacteria, while it influences the aggregation of the soil particles,* and thus affects the water supply But the doab soils, so far as is known everywhere contain adequate supplies of this substance

Silica alumina, and lime together make up practically the whole bulk of the soil The other mineral substances which are essential for plant life are present in such small quantities that they do not affect the appearance of the

* This point will be discussed further on in this chapter

land and can be detected only by special chemical methods, but they are essential all the same we have already enumerated them, potash, phosphoric acid, compound of iron, sulphur, and some substances which are not so well known The only other mineral which requires to be mentioned is soda, a substance which we know in ordinary life in such forms as common salt and washing soda In small quantities this substance is harmless or beneficial, but when there is anything over one part per thousand of it to the total weight of soil it is most injurious or fatal to all plant life as we see in the reh plains—reh consisting essentially of soda

To complete our account of the composition of the soil we must again mention (1) the decaying vegetable matter, (2) the bacteria of innumerable species, and (3) the water and air which it contains

Classification by materials.

The natural classification of the duab soils does not depend to any great extent on the materials of which they are composed Great differences in the amount of lime would, it is true make a marked distinction, but they do not apparently occur with any degree of frequency, except in the extreme north east of the provinces, where a soil remarkably rich in this substance is distinguished by the people under the name of *bhat* The quantity of soda when great indicates a distinction between plain usar and reh usar, but in the present state of our knowledge this distinction is of little practical importance, as both classes are unfit for cultivation When the silicates of alumina are present in quantity the soil is sticky when wet and apt to crack when dry, as we see in the rice lands, but these peculiarities are due not so much to the nature of the material as to the smallness of the particles Vegetable matter is important in classifying soils by position, but not in the natural classification.

Recognition of different soils.

The difference between the three main classes, sand, clay, and loam can usually be recognised by the eye A further simple test is to moisten a pinch of soil and rub it between the finger and thumb Where the particles are very fine (that is, where the soil is clay) a slimy mud is produced with little or no grit where the soil is sand, there is no slimy feeling but the grit can be distinguished at once

Water contained in the soil

The reason why the average size of the particles makes such a difference that the people have taken it as the basis of their classification is to be found in the behaviour of water in the soil We have seen that the particles of soil are usually surrounded by a thin film of water from which plants derive both their moisture and their stock of plant food. Now, the amount of water held as a film will depend on the surface-area of the particle, and the smaller the particles the greater the surface area in a given quantity of soil For instance a cube of six inches has six faces, each of 36 square inches its total surface of area is therefore 216 square inches If the cube is cut into two equal halves the surface of each half is 144 square inches, so that the total surface in the space occupied becomes 288 square inches, and the more the cube is subdivided the greater becomes the total surface area, that is, the smaller the particles the greater the surface area, or the smaller the particles the greater the amount of water which will be held by a given quantity of soil

Downward movement of water.

Secondly, the smaller particles will pack more closely together than the larger, that is, the air spaces between them though more numerous will be individually smaller Now, the movement of water in the soil, both upward and

downward, is controlled by the size of these spaces Consider first the downward movement (that is, drainage) If water is poured on a layer of coarse sand, most of it passes at once through the spaces between the particles and runs away downwards If the sand is replaced by fine clay, very little water passes through, but most remains on the surface With loam some of the water will gradually drain away, but it will not run straight through as in the case of sand Thus then is one practical distinction speaking roughly, water passes freely through sand but not through clay

Capillary movement of water

But the downward course of water, though the most obvious, is not the only direction in which it moves If you wet the bottom of a lump of sugar, the whole lump gradually becomes moist, that is to say the water has travelled upwards through the lump Now it has been ascertained by experiment that this form of motion (which you will read of under the name of capillary movement) depends on the narrowness of the spaces separating the particles in the lump of sugar or other substance under consideration the narrower the spaces, the quicker is the rate of flow, at least so long as the spaces are wide enough to allow of any movement This capillary movement may go on in any direction and it takes place in such a way that the distribution of the water in the lump tends to equality If then we have the surface soil dry and the subsoil wet, water will constantly pass upwards from the wet layer to the dry until the amount of water in the two layers is more or less equal But the speed at which the water travels depends on the average size of the particles In coarse sand the pace will be slow, so slow indeed that when the wet layers lie a long distance below the surface the movement of water will practically cease In the finest clays too the movement will be comparatively slow, as the spaces are so narrow that obstruction results In the loams the movement will be

quicker, and among them the speed will be greatest where the particles are finest.

Loss of water from the surface

The practical importance of this upward movement of water is very great. In ordinary soils the surface is drier than the subsoil throughout practically the whole cold weather and also through a part of the rainy season any one can satisfy himself of this fact by digging holes in cultivated land. The reason why the surface is drier is that the water on the surface particles tends to pass away into the air at any time when rain is not actually falling. The rate at which this process (known as evaporation) goes on depends partly on the temperature and partly on the amount of water already contained in the air so that other things being equal the hotter and drier the air the more quickly does the surface soil lose its water. If then the surface soil could not obtain water from below it would soon become so dry that plants could not obtain water from it, and the growth of crops would be impossible. As a matter of fact we see that in a drought it is the crops on coarse sand which wither first, and those on fine loam which last longest. the former get little or no water from the deeper soil levels, while the latter have a steady and fairly rapid supply.

Again water leaves the soil not only from the surface but, as we have already seen, through the plants growing on it, a heavy crop will extract from the soil an enormous weight of water, nearly all of which passes into the air. This water is drawn from the soil immediately surrounding the roots, which are usually near the surface, and if there were no upward movement of water the soil in contact with the roots could not provide enough water for the needs of the crop. As a matter of fact the water drawn up by the roots is replaced by water from above if the surface is wet, and from below if the surface is dry.

Regulation of the movements of water so as to benefit plants.

Thus in the ordinary condition of the soil water is travelling upwards and escaping either at the surface or through the plants and except where water is in excess the cultivator obviously wants as little as possible to leave the surface which does him no good, and as much as possible to pass through the plants, which it helps to nourish on its way Now the process of evaporation is not beyond the control of the cultivator, indeed it is just in this matter that the skill of our best cultivators is most marked. He cannot of course control the amount of water in the air, he can however, to some extent, control the temperature of the surface soil The soil derives its heat from the sun and if some of that heat is kept off the soil will be kept comparatively cool and will lose less water than would otherwise be the case This shading of the soil is done by keeping it covered with crops the commonest device is the growth of low spreading crops in between high crops where the plants are wide apart, thus gourds are grown in maize fields, and urd and other pulses in juar fields, and so on This practice probably does not reduce the total amount of water withdrawn as the shade plants themselves have large requirements but it does reduce the amount withdrawn unproductively Further, the amount of water lost from the surface of a field depends on the state of the surface when the land is beaten down into a crust water escapes very quickly, while the escape is much slower when there is a layer of loose soil on top The reason for this difference is to be found in the laws which have been discovered regarding capillary movement, laws which we cannot discuss in this book. In practice the rate of evaporation can be reduced by loosening the surface with a plough or hoe, it can be increased by rolling the surface or flattening it by drawing any heavy object over it In the chapter on

tillage we shall see some of the ways in which the cultivator takes advantage of this principle

Behaviour of different soils with respect to water

We have now seen the fundamental distinction between the different soils clays hinder the downward passage of water and to some extent retard its upward movement they will sometimes be too wet and sometimes too dry sand lets water escape downwards too easily and does not let it come up at sufficient speed it will often be too dry rarely too wet (unless the escape of water is prevented an important exception which we will notice in detail in the chapter on drainage) Finally in loam the movement of water both upward and downward is regulated to the best advantage

Formation of reh

As we have just been considering the question of evaporation it will be convenient here to notice the fate of the soda which as we have seen exists in the duab soils and which in quantity is fatal to all cultivation Soda behaves in the soil like potash (*vide* Chapter I) Most of it is in the form of insoluble compounds which gradually wither and give up the soda in a simpler state Where there is a downward movement of water that is during and after rain in sand and loam the soluble soda is washed out of the soil and escapes into the drainage water ultimately reaching the sea where most of it is found in the form of salt Hence in properly drained soils the free soda is not accumulated to a dangerous extent In the clays however the soda has a peculiar effect on the clay particles which is termed deflocculation it breaks up any aggregates of these particles such as are ordinarily formed and the soil becomes a mass of the finest particles only and these so closely packed together that there is practically no downward movement of water The soda then cannot be washed out

of the soil by this means and consequently in the dry season the accumulation tends to move upwards with the water in which it is dissolved Soda cannot, however, like water, pass away into the air so that, when evaporation takes place it remains at the surface and appears as a white crust or dust on the soil This crust is dissolved again as soon as the surface is wet and is carried down into the soil so far as the water penetrates but is not washed out, and is ready to rise again as soon as the surface dries The problem of utilising land of this sort is too complex to be discussed here *

Loss of plant food by drainage.

The question will naturally be raised why loam and sand, which readily lose their soda by drainage, do not also lose the potash and phosphoric acid which are also soluble in water As a matter of fact such loss does not occur to a material extent because the substances tend to become insoluble in the conditions which then prevail, but the processes which take place cannot be explained here The fact remains that while the injurious soda is rapidly lost, potash and phosphoric acid remain in the soil nitrates on the other hand are lost almost as readily as soda, but it will be remembered that they are produced by bacteria and used up almost as rapidly as they are formed probably therefore they do not lie in the soil long enough to be lost in great quantities, but the extent of the loss has not yet been ascertained in these provinces

Summary of the effects of water in soils.

It will perhaps be well if we recall at this point the principal ways in which the soil water is important to the crops An adequate supply is needed by the plant for its growth

* It is often urged that the methods which have been successful in washing salt out of the soil in other countries would be equally successful with soda here but this suggestion overlooks the fact that salt does not break up the aggregates of particles as the soda of our soils does

and also to carry the nitrates and the mineral plant food while a certain degree of moisture is essential for the efficient work of the soil bacteria Too much water, however, reduces or suspends the activity of the bacteria and at the same time cuts off the air supply from the roots Thus, on the whole the regulation of the supply of soil water is the greatest necessity of all, once the plants have started to grow, and consequently there is every reason to base the classification of soils on their behaviour in this respect At germination, however, water fulfils yet another function. We have seen that successful germination depends on the moisture and the temperature of the soil but the temperature itself depends to some extent on the moisture since the process of evaporation reduces the temperature We make use of this principle when we cool our houses by a thermantidote we force the air to take up moisture knowing that it will be cooled in doing so In the same way if a field is too hot for sowing (as is often the case in October) it can he cooled by hastening evaporation which as we have seen, can be effected by rolling the land. It is not, on the other hand, practicable artificially to warm land which is too cold for sowing, but the question seldom or never arises in the duab, as the sun can usually be trusted to bring the soil to a sufficient temperature

Improvement of soils in respect to water.

Now, seeing the extent to which the value of land depends on the average size of the particles we may consider what can be done to improve land which is defective in this respect The first obvious suggestion is to mix soils to put clay on the bhur and sand on the usar Unfortunately this process is usually so expensive that it cannot be carried out profitably For instance to put a layer of sand one inch deep on usar will require over 120 cart loads of sand to the acre, and sand is usually not to be had close to the usar, so that the expense of sanding becomes very heavy, while we

know by experience that a dressing of so little as one inch of sand makes very little difference Apparently claying sand is more likely to be profitable, as a little clay has more effect on sand than a little sand on clay, the process has in the past been extensively carried out in England and I have heard of a few persons in Oudh who have tried it on a small scale but it is not in general use The Oudh practice of scattering clods dug from tanks on the fields has some effect in this way, though its principal benefit appears to be in the fact that these clods contain a certain amount of organic matter derived from the water of the tank However broadly speaking, we may say that the process of mixing soils is not carried on in these provinces and that its cost will probably continue to stand in the way of its adoption in most cases Another possible course is to alter the size of the particles already present we can not in practice break up those which are too large, but there is a means of making small particles adhere together and form larger complex particles thus opening the texture of a clay This is done by means of chalk or, better, quick lime if you shake up a little heavy clay in a glass with water you will get a turbid brown liquid which does not clear rapidly on being allowed to stand, if to this you add a little lime the liquid clears almost at once and the solid matter settles in the glass, not in a slime but in small lumps Clays are regularly limed in England and other countries in order to open them up in this way by forming larger particles, and the same treatment is apparently effective on some of the heavier clays in these provinces, but here again the question of cost is serious we need perhaps ten tons of lime to the acre and the cost of this may approach, if it does not exceed the price that the land would be worth if entirely reclaimed

Another method of improving defective texture is to add organic matter to the soil, but it will be more convenient to

postpone this subject till we have considered the alterna tive system of soil classification, which depends on the amount of organic matter

Natural classification of *soils.*

We may now sum up the characters of the natural soils as follows :—

Clay —Most of the particles are very fine and readily cohere The soil forms compact masses it will absorb a large quantity of water, but will not allow any great quan tity to pass through. When wet it forms a slimy mud When dried its surface is cut by cracks, owing to its bulk shrinking in consequence of the loss of water When the soil contains considerable quantities of soda, the surface will in dry weather be covered with a white crust

Sand —The particles are large and do not adhere to- gether, so that the soil is loose It will absorb less water than the same bulk of clay, but will allow water to pass freely through it, and will dry very rapidly It will not form mud when wet or crack when dried, nor will it have a crust of reh.

Loam —All soils intermediate between clay and sand are called loams

It is obvious that these classes are not entirely distinct : it is impossible to lay down a definite distinction between the lighter clays and the heavier loams, or between the lighter loams and the firmer sands, so that questions regard ing the class of particular fields will often cause difficulties Classification is therefore a matter requiring judgement, and differences of opinion must be expected. For practical purposes the important point is that the classification should be as uniform as possible over the area under consideration : thus a settlement officer working in a defined area is con cerned to see that what is classed as loam in one village is not classed as sand in another but it does not much matter if the line between loam and sand or between loam

and clay is drawn differently in different districts What is important is to remember that the classification may and does vary in detail from district to district, though its general scheme may be uniform Again we often meet with sub divisions of these main classes, first and second class clay for instance these sub-divisions are made with the object of facilitating a settlement officer's work, and the line dividing them is almost always a matter of convenience

When therefore an officer comes to revenue work in a new district his first business is not to apply some scheme of soil classification which he has learnt elsewhere but to understand the scheme actually recognised in his district He will find the outlines similar, but the distinctions drawn at different points, in particular he will probably find that the general character of the locality has influenced the point of division, thus soil will be classed as loam in a sandy district which would be called sand where clay was predominant

Another point of some practical importance in classifying the natural soils is to distinguish culturable land from barren The question arises at both ends of the scale. There is no doubt that clays containing much soda are not culturable by the means at the cultivator's disposal, while the very stiff clays though not contaminated by soda cannot be tilled effectively On the other hand, the lighter clays are perhaps the most fertile soils of all Where to draw the line between these extremes is a question that can be decided only by practical experience Much depends on the density of the agricultural population, where the density is great and there is not enough good land for all, the inferior soils will necessarily come under cultivation The resources of the cultivators are also factors to be considered, strong cattle can till land which would be worthless with weaker animals The prevailing prices of produce

are also important Similarly with sandy land, the density of population and the value of produce contribute largely to determine the point up to which sand will be cultivated, but in both cases the facts of any locality can be ascertained only by study on the spot

Classification of soils by position, i e by amount of organic matter

We must now turn to the alternative system of classifying cultivated land according to its position with regard to the village site the artificial classification of *soils* The basis of this classification is the amount of organic matter present in or supplied to the soils It is obvious that under existing social conditions the fields immediately adjoining a group of houses will receive most of the refuse that is thrown away by the inhabitants and most of their excrement These supplies of organic matter are an important feature in all cases in addition the practice over the greater part of the provinces is to apply the available manure to the fields nearest the site thus avoiding the expense of carrying it to the outlying land Thus the fields nearest the site are most often manured fields lying a little further off are manured occasionally, and those at the greatest distance get no manure at all The result is obvious to the eye when the crops are on the ground each group of houses is a centre from which the fertility gradually decreases to the outskirts of the land depending on the village or hamlet The most remunerative crops are found near the houses and the inferior crops further off

The highly manured land round the houses is known variously as goind gauhan or bara the outlying unmanured land as palo, uparhar or by other names the intermediate zone usually as manjhar Obviously the point at which one class passes into another will in this case also be a matter of opinion, and the remarks made above as to the natural classification will apply with at

least equal force In some cases the classification has been simplified by the omission of the middle zone, so that only two classes are kept, the homeland and the outlying land

The character of the gauhan or homeland will depend first on its natural features, that is, on the nature and size of the mineral particles, the greater quantity of organic matter will however enable it to hold more water than it otherwise would, since organic matter can absorb large quantities of water Secondly, the large supply of organic matter will support increased numbers of the small living beings which form nitrates, and the supply of nitrates will be more rapidly increased Thirdly, the manures applied will incidentally return to the soil in an available form some of the mineral plant food which has been removed from it by previous crops The distinguishing features of the home land is however its wealth in nitrates, and, on the other hand, the outlying land is usually marked by its poverty in this form of plant food In practical revenue work it is however most important to remember that the fertility of the homeland is largely controlled by its original character Where a group of houses has been built on heavy clay the fields round them will never be so good as if the land had been loam, the defect of the clay (obstructed drainage) remains almost untouched Sandy land, on the other hand, benefits enormously by proximity to houses since the addi tion of organic matter tends to remedy the rapid loss of water which is its most obvious defect In some districts where the classification of soils is very detailed account is taken of these facts, and the gauhan is divided into gauhan dumat, gauhan bhur, &c , elsewhere the same facts are recognised by dividing the gauhan into two classes, superior and inferior

It is interesting to notice that the distinction between homeland and outlying land decreases in the provinces from East to West No one could fail to notice it in (say)

Jaunpur or Partabgarh, while the crops are on the ground, while in Bulandshahr or Meerut the distinction is often imperceptible. The reason of this is that the practice of cultivators differs: the western cultivators, especially the Jats, are accustomed to manure all their land, home and outlying in turn so that no portion is specially favoured, the homelands may not give so good a yield as further East, but that of the outlying lands is much superior. Probably on the whole the western system gives a greater yield of produce from a given area but it does not follow that it would be more economical for the eastern cultivator to adopt it. The Jat cultivator usually has a cart, and can spare cattle to cart the manure to a distance: the eastern cultivator cannot do so, and the cost of carrying it in head loads may be prohibitive. This point, the economy of the labour available, will need our attention further on it is mentioned here merely as furnishing a partial explanation why the soil classification in the West must frequently proceed on different lines from those found most suitable in the East.

For the sake of simplicity we have spoken of the system of manuring as altering from East to West, but the same change is noticeable to some extent as one goes from South to North (Bundelkhand being of course left out of account). In this case too the change is probably due in part to the larger stock of cattle which can be maintained in the more northerly and damper districts.

Another difference between East and West is the position of the cultivator's house. In the west the houses are usually aggregated in large villages, and the outlying fields are far distant, while in the East single houses and small hamlets are much more commonly found. The result is that the manure-supply is more widely distributed in the East than would be possible if the western system of large villages prevailed.

Increasing the organic matter of soils

Obviously the amount of organic matter present in the soil—being the result of man s efforts—can he altered by man that is to say, if you treat outlying land with heavy dressings of manure such as are given to the homelands, it will gradually approach the homelands in fertility And indeed this process can be seen at work in places where the refuse of a large community is trenched in the soil far away from houses, the resulting soil is of the highest fertility But in the country the amount of organic refuse is not so large as to render this course practicable, and if it is desired to improve land in this way the organic matter must be prepared specially The usual course in other countries is to grow some cheap crop on the land to he improved and leave the whole crop on the land ploughing it in, so as to hury it in the soil If a leguminous crop is used, the soil will in this way receive all the combined nitrogen which the crop has obtained from the air, as well as all the matter manufactured by the plant from water and carbonic acid, and in any case the latter products will he added to the soil As a matter of fact this process is almost unknown in these provinces, a man with a small holding cannot often spare the land for a season as he needs the whole produce of his holding to support his family for the year, while the cost of seed, small though it seems, is an important matter to the small cultivator Further, the process of ploughing in requires some judgement in order to secure that the crop shall he put under the soil in condition favourable for the work of the proper hacteria otherwise, as will be under stood from what has been said above, the combined nitrogen may pass either into the air or into tho drainage and he lost The experimental ploughing in of green crops on fairly fertile soil at Cawnpore has given contra dictory results in practice, and it seems that this method of increasing the organic matter of the soil should be

necessary If therefore the water in the sand cannot escape it remains as a reservoir from which the loam can draw water to replace what is evaporated As a matter of fact water can in such cases usually escape, though not very rapidly, the surface of the underlying clay is ordinarily somewhat sloped and the water will gradually travel down the slope Now if we suppose that at a little distance a ravine has cut through this layer of clay the water flowing on the clay will appear on the side of the ravine and will flow down to the bottom If we look at a ravine some time after heavy rain we can often see the water oozing out from just above one or more layers of clay So much of this water as is not evaporated flows down the ravine till it reaches a river and thence goes on to the sea Of course this water carries with it the injurious soda salts which it has dissolved in passing through the loam the ultimate destination of these is the sea But the sea is constantly losing fresh water by evaporation while the soda salts remain in it it is therefore gradually getting salter and in fact we may assume that its saltness is due mainly to this steady accumulation of what has been washed into from the soil

This then is an instance of drainage of the simplest kind Where the clay bed is not cut by a ravine the water continues to pass over it and possibly it may come to flow under a second clay bed there we get a layer of saturated sand between two layers of clay Further on the original layer of clay may get thinner and thinner till at last it disappears and the layer of sand unites with another that lay below it Experience gained in sinking wells shows that the surface soil rests on successive layers of sand and clay and that these layers are often not continuous over a large area a bed of sand may be entirely enclosed by clay or a bed of clay by sand.

Unless the sand is entirely enclosed by clay, it will usually at some point touch on a ravine or river bank, and water will drain out of it at this point in the manner described above while a bed of sand so enclosed by clay that any flow downwards is prevented can lose its water only by evaporation upwards through the surface soil. Thus all the water that passes through the soil is accounted for: but much of the rainfall flows over the surface of the stiffer soils till it either enters a ravine or collects in a natural depression, or what we know as a jhil.

Flow of water through sand.

It is important to know that water does not flow through sand as quickly as it flows over a smooth clay surface much time is lost in passing through the sand, and the flow is thereby retarded, the coarser the sand and the greater the slope, the quicker is the flow Natural drainage is therefore a slow process, and sand may remain saturated for a considerable time if the water has to travel for a long distance through it We may also note that, though for simplicity we have considered the clay as impervious, many clays will let some water pass downwards through them, though the amount is small compared to that which passes through sand

Effect of natural drainage on cultivation.

It will be seen from this description that the value of most surface soils for cultivation will depend greatly on the nature of the underlying layers. Thus a coarse sandy soil lying immediately over a heavy clay will get water-logged very quickly, while it will dry up in a very short time: the crops on a soil of this kind will therefore suffer greatly in wet and dry seasons alike. On the other hand, a clay soil, if the surface layer is at all thick, may be almost independent of the nature of the underlying layers, as so little water can penetrate through to them: this

remark applies in particular to many usar soils which consist of a solid block of clay several feet thick. On the whole, the soils which suffer most from want of natural drainage may be divided into three classes (1) the heavy clays, (2) the light soils underlain by heavy clays, and (3) the lower parts of natural depressions We may now proceed to consider what measures can be taken to remedy these defects

Methods of artificial drainage.

Artificial drainage can be carried out either by surface cuts, leading to a ravine or river, or by underground channels or by drainage wells A drainage well consists of a hole pierced through a clay stratum so that water can flow through to the sand below it These wells are not in use to any extent in these provinces, and we may pass over the details of their construction Underground channels, which have usually to be lined with earthenware pipes to prevent their choking, are common in many countries; but they involve a considerable capital outlay, and are not used in these provinces, so we may pass over them also Open drainage cuts, on the other hand, are common features of all canal districts they are simply channels dug from the place which needs drainage to the nearest ravine, and their construction is simple, their alignment on the other hand usually requires accurate surveying and trained judgement, and wherever possible an experienced engineer should be employed to carry out the work

Drainage of clays

Now of the three classes of land requiring drainage, the heavy clays containing appreciable amounts of soda cannot apparently be drained effectively by surface channels such channels receive water from the surface but they do not any extent provoke a flow of water *through the clay* which, as we have seen, is essential to wash out the

injurious soda compounds and keep the land aerated. Underground channels have been tried on such lands, but so far without success as the fine particles of clay get into the pipes and choke them The expense too is so great that it is very doubtful whether such drains would ever pay Drainage wells have been tried so far without success so that the problem of draining these soils is still unsolved The lighter clays containing little soda can on the other hand be drained more or less effectively by surface channels

Drainage of light soils

The second class light soils resting on heavy clays could apparently be treated by drainage wells, but this has not been tried open channels are usually cheaper The question of draining such soils is however complicated by the fact already pointed out that they dry very quickly The more you drain them the more they will suffer in drought and as irrigation of such soils is expensive and unsatisfactory, drainage may do more harm than good. What is usually required in such cases is merely to keep open the natural drainage lines rarely to supplement them by artificial cuts We usually find natural drainage lines running through the bhur tracts they may be well defined streams with a regular though sluggish flow or they may be found as a line of jhils separated by barriers of sand As long as they are flowing they show that drainage is proceeding, and to increase the rate of flow may do more harm than good at least it should never be undertaken without careful expert examination of the particular locality Where however there is no regular flow, and the people complain of oversaturation it is usually desirable to cut through the barriers obstructing the stream and enable the water to flow away, *not* so much as to empty the jhils rapidly, but just enough to maintain a slow current The barriers which separate

the jhils are formed naturally in streams that flow near sand If you look at a place where water has flowed into such a stream you will see that it has left a more or less fan shaped heap of sand at the point where it has entered the current the reason of this is as we have seen that the amount of sand which can be carried by flowing water depends on the rate of flow the speed of the water is checked where it meets the stream and the sand is deposited As time goes on bars of sand may be formed across the stream damming it up and thus the flow of the stream is reduced and it in turn drops some of the sand which it carries If a heavy flood comes down such a stream it may tear these bars away otherwise the stream may be gradually cut up into jhils and the water from the underground sand can no longer escape the country will therefore get more and more waterlogged By cutting a channel through the barriers we only restore a stream which has been accidentally interrupted

It follows that the prosperity of these sandy tracts depends to a large extent on regular attention to their drainage lines But what is everybody's business is nobody's business and individual landholders do not as a rule keep their drainage lines in order besides one negligent landholder can obstruct a whole channel Such drainage channels therefore demand the care of the authorities

Drainage of natural depressions

The third case of obstructed drainage natural depressions in the surface is usually dealt with by open drains which can be cut through the higher ground surrounding the depression and on to the nearest stream or ravine The questions whether it is desirable to drain a particular depression and if so to what depth are exceedingly difficult to decide and no general rules can be framed for dealing with them each case must be decided on its

merits The problem usually presents itself somewhat in the following form we have a shallow depression with gently sloping sides the higher parts of the slopes are fairly good loam and are irrigated when necessary from the water contained in the depression below this there is heavier soil usually fit for rice and also irrigated in the kharif when necessary below this again there is the stiff clay bottom on which the water lodges Now in a year of very heavy rainfall the depression may almost fill up with water, the rice may be entirely lost and the kharif in the loam higher up seriously injured further it may be impossible to take even a rabi crop off the rice fields as they do not dry up enough for cultivation Thus in a very wet year much of the land is wholly useless but there is an ample supply of water for the rabi irrigation of the higher fields In a dry year on the other hand the kharif will probably be good but there will be little or no water for the rabi irrigation indeed there may not be enough even to keep the rice alive at the end of the kharif If a drain is cut so that the surplus water can flow away the evils incident to a wet year are avoided but those of a dry year are intensified as water has drained out that would have been invaluable later on Whether such a drain is on the whole a benefit or an evil depends on the local circumstances If wells can be made easily and cheaply on the higher parts of the slopes so as to protect these in dry seasons the drain is usually a great advantage so it is if the lower parts of the slopes are agriculturally of much greater value than the higher parts On the other hand if the higher parts are the more valuable (they are nearly always from the nature of the case more extensive) or if they cannot be otherwise irriga ted the drain may become a great evil

If a landholder or an officer has to decide whether a drain should be made in such circumstances, his only

safe course is to hear the views of all the cultivators who would be affected by it and estimate as far as he can the relative advantages over a series of years He will of course allow for the fact that cultivators all of whose land is on a high level will bitterly oppose a drain which may be demanded as a necessity by those who hold only on the lower slopes If the balance of advantages is in favour of the drain he may have to satisfy individuals by a small reduction of rent or by giving them a bit of land in a better position while he can (subject to the rent law) test the desire for the drain by ascertaining whether those who demand it are willing to pay a small enhancement

The level to which the drain is to be dug must be decided partly on engineering and partly on agricultural grounds It may for instance be found that to dig a drain to the depth that would give the greatest advantage would involve an excessive amount of earthwork while a drain a few feet shallower could be constructed at a very much smaller cost and do nearly as much good Or the more efficient drain might have to pass through land belonging to some one else who would object to its construction while the alternative might lie entirely in the village All such questions have to be gone into thoroughly before a drain age proposal can be fully dealt with

Cases may occasionally be found where a large tract of country contains many land locked depressions and could be benefited materially by a large main drain into which the depressions could discharge their surplus water Cases of this kind have been successfully dealt with in tracts where the introduction of a canal has necessitated Government interference outside the canal tracts such projects cannot be carried out without great difficulty, as it is very difficult to secure unanimity among a large body of landholders and no satisfactory means have yet been devised for distri buting the cost among those who will derive benefit from

the work in many cases too the discussion of such a project may produce so much ill feeling among neighbours that any good it might do is more than counterbalanced

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Chapter V.—TILLAGE

Implements and their use

We have seen in the first chapter that the method of tillage affects almost all the conditions of plant growth which the cultivator can control We have now to enquire how these operations are carried out The cultivator uses ordinarily four implements the plough, the clod-crusher, the spade, and the hoe The plough is a wedge shaped block of hard wood with an iron sole it has a handle by which it is guided, and a beam projecting in front by which it is drawn. When the plough is drawn through the ground the point of the wedge cuts a furrow and the body of the wedge presses the soil at the side into the space left by the last furrow, but does not to any great extent invert the soil the soil is thus stirred up and if it has been packed together, broken into smaller pieces The art of using this plough consists first in using it at the right time and secondly in working it evenly If the ground is wet and muddy it is useless to plough, as the soil does not get broken up while if the ground is hard and dry the plough cannot be worked properly by bullocks, but merely makes a scratch on the surface of the soil The ground must, therefore, be neither too wet nor too dry but only practical experience can enable a man to judge whether land is fit for ploughing or not Much depends on the consistency of the soil a light sandy loam can be ploughed when to plough a clay would be a waste of labour, or would even do harm by working the surface into regular mud. As regards the working of the plough it is important to get an even depth so that the whole field may be tilled uniformly, the depth

usually attained may vary from three to five inches according to the size of the plough, which in its turn depends largely on the strength of the cattle available thus the rich cultivators of the western districts, who can afford and are accustomed to use powerful cattle, have their ploughs made larger and heavier than those of the east Again, it is important that the furrows should be straight and at a proper distance apart if they are crooked, or too far apart, spaces of untilled land will be left between them, and the field will be patchy The regulation of the plough's course is effected by pressure on the handle, and its management can be learnt only by practice

The clod crusher is merely a flat log of wood which is drawn over the field by bullocks, the driver standing on it It breaks many of the clods left by the plough and also smoothes off the ridges so that a level surface is left In some of the western districts a roller of wood or even stone is occasionally used instead of a flat log The spade (phaora) is used mostly for odd jobs, such as mending or cutting a field boundary digging a corner left by the plough, &c., but an important use is for tilling land intended for valuable crops which require a deep soil A whole field is then dug over by the spade to a depth of ten inches or a foot, that is much deeper than the plough can reach again the fields bearing a crop of young sugarcane are often dug between the plants with a narrow form of spade or a broad pick The spade is also used for breaking up new land, for instance when a piece of heavy clay in the khadir is to be brought under cultivation, it is sometimes so firm and so full of roots that a plough cannot be worked, if so, it is dug with a spade and allowed to weather, after which the plough can be used The spade is also used for tillage by persons who have only a small field or two of land and cannot afford to keep bullocks Finally the hoe (khurpa) is a small iron blade fixed in a handle which can be used

for a great variety of purposes its principal use in tillage is to remove weeds and to loosen the surface soil round young plants

Kharif tillage of an ordinary field.

The methods by which the cultivator uses these simple instruments to produce a most effective result can best be explained by describing the treatment of a field intended for one of the staple crops First then we will take a kharif crop such as maize The field has probably been under a rabi crop cleared away in April its surface soil is dry and more or less compact, and it cannot be ploughed to advantage until rain falls If a storm comes in the end of May or early in June the field will be ploughed roughly This breaks up the surface and admits air into the soil, thus probably facilitating the formation of nitrates, but the immediate object of the cultivator is to make the field ready to retain the next rain. When heavy rain falls on a dry and compact field, much of it flows off the surface, bearing with it some of the surface particles of soil, which presumably contain plant food in a soluble condition thus both water and plant food are lost When, however, the land has been ploughed, the roughness of the surface prevents the rain from flowing away and nearly all of it soaks into the ground. Thus an early ploughing secures that the soil shall get thoroughly wet sooner than would otherwise be the case When the rain has come in earnest, ploughing will be resumed as soon as the surface has dried sufficiently usually at least two more ploughings will be given but the exact number will depend on many factors the work to be done on other fields, the ploughs and cattle available, the weather, &c. &c. The cultivator will aim at having the soil as thoroughly stirred and pulverised as possible in the time and with the means at his disposal and he will sometimes cross plough, that is, plough first along and then

across the field to secure this object he will then sow his seed When the seed comes up the young plants will not be alone in the field the seeds of innumerable weeds, which are always in the soil, will germinate in the condi tions which suit the seed sown and if these are allowed to grow the land will be overcrowded the next operation therefore is to remove the weeds before they injure the plants This is done by scraping the surface of the field with the hoe, the weeds are thus either uprooted or sovered from their roots and soon wither they are gathered into heaps on the boundary and usually left to rot (Some weeds are suitable for human or animal food and these of course are used and not thrown away) The surface soil, which has probably packed under the influence of rain, is loosened by the hoe in removing the weeds this is an important benefit as the loss of water by evaporation goes on much more rapidly from a packed smooth surface than when the surface soil is loose, and even in the rains the cultivator has to think of saving the moisture in the soil, for the heat of the sun is so strong that the surface soil dries very rapidly, and the luxuriant crops grown at this season consume immense quantities of water In some seasons, and with some crops, it may be necessary to hoe the soil once more, in order to save the moisture this will happen when the soil has again been compacted and rain holds off another hoeing will then be of service in the same way Other occasional operations may be necessary during the kharif it may be necessary to drain off water that has lodged on a low lying spot, or to bank up earth round plants (e g maize) that get top heavy as they grow but the main process is over when the cultivator has thoroughly broken up the soil before sowing, has removed the weeds and has loosened the surface soil to the extent that may be necessary to keep the field thoroughly moist

Rabi tillage of an ordinary field.

Tillage for the rabi will usually begin in August as soon as the kharif crops have received attention if however, the land has been bare since the last kharif, one ploughing will have been given in the cold weather provided enough rain has fallen to make this possible This, by breaking up the soil, will facilitate the disintegration of some of its particles into soluble forms, and also the manufacture of nitrates From August to September the land will be ploughed as often as can be managed, having regard to the weather and the urgency of other work In this way the cultivator will by the middle of October have the fields intended for wheat and other good crops thoroughly pulverised and in excellent condition for sowing The after tillage in the cold weather depends largely on the irrigation if it is found desirable to irrigate early while the plants are very small and much of the ground bare, the irrigation will perhaps be followed by hoeing to keep in the moisture but if the first irrigation is delayed until the ground is well covered hoeing will be unnecessary and might be injurious to the thick growing plants No further tillage is then required

In both seasons then tillage is, on paper, a simple thing requiring only that the soil should be pulverised as completely as the time and the cultivator's resources will allow, and that the surface of the land should be kept loose while the crop is young, but practical experience is quite essential not only to do the work thoroughly but to know when it should be done The result of tillage as carried out by an expert cultivator is to produce a layer of loose, finely pulverised soil four or five inches deep on top of the unaltered soil this layer is ample for a seed bed in which the seeds can germinate and the young roots make a start, later on they have to grow through the untilled soil lying below This loose layer of soil dries rapidly, but as has been said

above it serves as a protection to the moisture in the soil lying below which is the source from which the plants must derive most of their water as soon as their roots have developed to any extent

Depth of tillage

The want of depth in tillage is an objection frequently urged against this system of cultivation Now the cultivator knows that in certain circumstances a deeply tilled soil is an advantage and he often digs a field with the spade when growing crops such as potatoes or vegetables which will pay for the cost But the time occupied and the cost incurred in digging make it impossible that any large proportion of the land of the duab can be cultivated in this way and the cattle of the country are not as a rule strong enough to draw a plough much deeper through the soil It must be remembered too that in really deep cultivation a greater quantity of soil is almost necessarily exposed for a time to the direct sunlight evaporation is therefore increased and more of the stock of moisture is lost it seems probable then that tillage to a relatively great depth would not be an advantage and this conclusion is supported by the results of experiments On the other hand there is now little doubt that somewhat deeper tillage in the course of which the soil is inverted is profitable provided that it can be done by the cattle at the cultivator's disposal, and there are now on the market several types of ploughs which fulfil this condition and whose low price puts them within the reach of all substantial cultivators

Possible improvements

The worst feature of the ordinary system of tillage is that it takes an excessive amount of time When the weather is unfavourable, the number of different ploughings required cannot always be accomplished in the time available and therefore either the seed is sown late

(sometimes a serious disadvantage as will appear further on) or it is sown on land that is not properly tilled Another defect is that the plough cannot make its way through a dense growth of weeds such as is to be found particularly in khadir land when tillage has been prevented until the end of the rains and another is the tendency of the country plough and clod-crusher to heap up the soil at the corners of the fields which gradually develop a saucer like surface in which crops grow badly

All these defects can be removed by the use of an iron soil inverting plough of one of the types to which reference has just been made A single ploughing with one of these does more good than three ploughings with the country plough it does much more effective work in weedy land and it can be so used as to counteract the tendency of the fields to form saucer like depressions The introduction of such a plough is therefore desirable on all substantial holdings The fact must however be borne in mind that an iron plough will not serve all the purposes of the country implement It is required for the early ploughings but in the later operations it is desir able merely to stir the soil and no to turn it over The stirring can be done by the ordinary plough but more quickly and efficiently by a cultivator or harrow either implement consists in essentials of one or more rows of iron hoes fitted to a frame the frame is drawn over the ground by bullocks and the hoes stir the soil The adoption of an iron plough consequently involves a re latively great increase in the capital invested in imple- ments but the investment is well worth making on all but the smallest holdings

Use of the clod-crusher

As has been noticed incidentally the use of the clod crusher (patah or pateli) is not only to level the field and break the clods thrown up by the plough but also by

compacting the surface to bring moisture from the lower layers to the surface soil. If you go on working a plough in the upper three or four inches of soil, you get, it is true, a finely pulverised seed bed, but it is often too dry, the water which it contained has passed into the air, while the capillary movement of water from below is interrupted as we saw in a former chapter. When, however, this loose layer of soil is pressed down by the patah, the capillary movement is facilitated and water comes from below into the surface soil. It will then be understood that it is as impossible to lay down rules for the use of the patah as for the use of the plough. the general principle is to use the patah when the surface soil is too dry for a proper seed bed, so that it is more frequently used in the rabi than in the kharif, but it is used in the kharif too when the circumstances require it, and it is only by practical experience that its proper use can be learned.

General remarks.

The art of tillage then consists first and foremost in getting a proper seed bed that is to say, in having the soil just in the best condition for germination in respect of texture warmth and moisture. If the seed bed is much too cold or too hot, much too wet or too dry, the seed will not germinate at all, while even if the defect is only slight, the plants will start growing rather weaker than they should and some of the seeds may not even start, so that on the whole the crop will be poorer than if the seed bed were exactly right. The crops sown in the same season differ considerably in their requirements for instance, the best seed bed for gram is not altogether suitable for wheat, and the cultivator must, and does, know the requirements of each. If the field is too wet and too hot he waits till it dries and cools,—processes which go on together, if it is too dry and too hot, he waters it so that it is cooled as the water dries, be

scarcely ever has a field too dry and too cold except for sowing sugarcane but if he has he must wait till the sun warms it and then water it while finally if it is too wet and too cold he can usually do nothing but wait till the next season In many cases he has to be content with a field imperfectly pulverised for if he waited to plough it oftener it would get too cold or too hot or too dry according to the season, thus continued wet weather in September and October usually means bad tillage for the rabi

After the seed is sown the art of tillage consists in keeping the land free from weeds and regulating the supply of moisture by loosening the surface or leaving it untouched thus it is bad to hoe maize when the land is very wet for then the superfluous water should be allowed to evaporate away as rapidly as possible but if the field is getting too dry it must be hoed at once to check the loss as much as possible Alike before sowing and after sowing judgement is required at every step and sound judgement can be based only on long experience Fortunately each cultivator has not to acquire all his experience by his own mistakes he begins to work on his father's land or perhaps goes out as a very small boy to work for wages and by the time he comes to manage a holding of his own the stock of experience he has acquired, together with the common knowledge of his neighbours is usually sufficient to save him from the most serious mistakes But there are great differences between individual cultivators in this matter of judgement some men will be found in most castes and most villages with an almost unerring judgement and others who never get the most out of their land On the whole however the average is highest among those castes such as Kurmis and Lodhas who are by long custom cultivators and nothing more and lowest among those who (like many Brahmans) think manual labour beneath their dignity so long at least as they can pay some

one else to do it for them But the least skilful cultivators are constantly being weeded out : when a run of bad seasons sets in, they get behind with their rent and lose the whole or part of their land, which goes to those who have enough ability to enlarge their holdings, and thus the average of skill does not deteriorate but probably increases slowly from generation to generation

Tillage of fallows.

As will be seen in a subsequent chapter, the usual rotation on land that is cropped once in the year is to take a kharif crop in one year and a rabi crop in the next The land in such cases lies fallow from about November to October in one year and for April and May in the next Cultivators know in general terms that it is well to plough the fallow instead of leaving the surface to compact, and the most industrious cultivators make the most of every fall of rain to get some of their fallow ploughed. The practice has two great advantages In the first place it promotes the welfare of the beneficent bacteria of the soil, and if the conditions have favoured them during the period of fallow the next crop starts with far better prospects than would otherwise be the case In the second place, most of the serious insect pests that cause recurring loss to the kharif crops depend very largely on the soil and stubble being left undisturbed, as will be explained in chapter X, and if the stubble is ploughed in good time, the number of insects will be greatly decreased in the following season It is desirable therefore that the practice of ploughing fallows should be extended as widely as possible

Its extension will be greatly facilitated by the use of soil inverting ploughs, because it has been found by experience that if one ploughing is carried out with such an implement, the subsequent cultivation can be easily effected without depending on rain or irrigation If then

a start can be made, the fallow can be kept in good condition up to the time when it is sown. The first ploughing however requires either irrigation or a fall of rain, or in the alternative a special type of plough. Rain cannot be depended on, and irrigation with this object is likely to be confined mainly to fields on to which canal water can flow without being lifted, the practice could probably be extended by the grant of specially low rates for canal irrigation for this particular purpose. The most suitable type of plough for breaking up stubble in dry weather has not yet been determined, but the operation has been proved to be possible. Individual cultivators cannot be expected to keep such ploughs for a single purpose, but one such plough kept in a village would enable all the cultivators to break up their stubble in turn, and its provision will probably be within the reach of the ordinary landholder or co-operative society.

Chapter VI.—SOWING AND SEED.

Time for sowing.

We have seen in the last chapter how the cultivator prepares a good seed bed, the next operation is to put the seed in the ground. In this matter, as in tillage, the greatest difficulty is to know when to act. In ordinary seasons the cultivator rarely makes a mistake, but his experience is occasionally at fault in exceptional weather, and sometimes he has to take a good deal of risk. For instance, after the failure of the rains in 1896, it was of the utmost importance to each individual cultivator to get as large a rabi crop as possible. Seed was no doubt very dear, but advances to meet its cost were readily given both by Government and by the majority of landlords, and so a large area was sown that would probably have been left fallow if the need of producing food had been less urgent,

or if there had been less help in obtaining seed Some of the fields so sown gave an adequate return while others did not but there is no doubt that the outturn of food was on the whole far higher than if the people had not been helped to sow The principle thus established is that when there is a serious deficiency in the kharif and when the ground is rather dry in October cultivators should be given every facility for obtaining seed and left to decide each man for himself whether it is worth while to take the risk of sowing it No one else Government or land holder can possibly decide this question it must be left entirely to the individual cultivator

A similar question will sometimes arise when the early rainfall in June and July is unusually light and the principle is the same at this season however, the cultivator can usually afford to wait longer as there is always a chance of copious rain coming to change the situation while rain in the end of October or early in November is exceedingly rare A more common risk in the kharif is that heavy rain may come just after a large area has been sown the soil will be for a time too wet for germination and the seed may either rot entirely or at best germinate weakly or partially This is a risk which the cultivator cannot avoid if the seed is lost there is usually time to resow the land if more seed can be got so that the loss is not very serious for instance 20 lbs of maize sown on an acre may yield 800 lbs of grain the net increase being 780 lbs , if the field has to be sown twice over, the net increase is reduced to 760 lbs not a very material difference The loss of course is greater if a larger weight of seed has to be sown wheat for instance requires about 100 to 120 lbs to the acre And there is often a difficulty in getting a fresh supply of seed a cultivator who usually saves his own seed will as a rule have to buy his second supply when prices are very high and there is little money

in the house, while a man who depends on his banker for seed may find difficulties in getting a second advance The loss from the need of resowing is therefore very real, though it is not to be compared with that which results when the land cannot be sown at all

Method of sowing

If, however, we leave these questions out of consideration and assume that the state of the ground is favourable for sowing the important points to consider are, first, the placing of the seed and, secondly, its quality We have seen in the first chapter that each plant requires a certain amount of space from which to draw its nourishment if the plants are too crowded, individuals will be insufficiently fed while if they are too far apart, space will be wasted and the outturn of the field as a whole will be reduced The ideal system of spacing is to plant each seed separately after measuring the distance apart This course is more or less followed in a few cases where the seed is very expensive, seed potatoes for instance, are very costly, and these are sown in rows or drills separated by equal distances, while in each drill the potatoes are placed at equal distances apart the distances are not actually measured with a rod, but they are approximately equal The system of sowing sugarcane cuttings is practically the same.

This system takes a good deal of labour and time, and the cost increases as the individual seeds are smaller and as the quantity to be sown rises, with crops of intermediate value, such as wheat, another plan is followed, the seed being dropped by hand in a furrow or drill made by the plough * In this case the distance between the drills is regulated as each successive drill is made by the same

* In the western districts the rabi crops are usually sown through a bamboo tube attached to the plough in such a way that the seed falls in the furrow

plough working evenly but the seed is dropped by hand in the drills in such a way that, while each plant is assured of sufficient room on two sides on the other sides it may be crowded or unnecessary space may be left The result can be seen by carefully examining a drill of wheat in an ordinary cultivator's field here and there plants will be found crowded together, while elsewhere there will be blank spaces A certain amount of loss results by this method of sowing, but it is not serious when the seed is dropped by a careful and experienced labourer and in any case the cost of placing each seed separately in its exact position would probably outweigh the advantages to be obtained. With inferior crops again even the system of drilling is abandoned and the seed is scattered broadcast over the ploughed field, and in this case the spacing must always be defective, and an inexpert sower may cause considerable loss This system is therefore applied mainly to those crops which will not pay for anything beyond the minimum of labour, but it is frequently adopted with kharif crops such as cotton or maize, which would certainly pay for better spacing The cause is probably the hurry with which kharif operations have to be conducted, each favourable hour has to be made the most of if work is to be done in time, and broadcasting is much quicker than drilling There has been a marked change in practice during recent years among cultivators who can obtain canal water and a large proportion of the area under cotton and maize is now sown before the rains break in a seed bed prepared with irrigation The pressure on time during the rains is thus mitigated, and the practice has other advantages to secure its full benefit the cotton and maize should certainly be drilled

In some cases the patah is run over the field after the seed has been sown, while in others the surface of the land is left rough Whether it is used or not depends on the state of the seed bed, if it is on the dry side the patah will

be used to enable moisture to rise from below while if it is rather wet it will be left to dry as quickly as possible Hence the use of the patah after sowing is commoner in the rabi than in the kharif and in the rabi it is most usual when there has been little rain in the end of September and the beginning of O tober

Thinning and transplanting

Whether the seed is sown broadcast or in drills the cultivator as a rule uses a larger quantity than is actually required to cover land evenly His object is to guard against some of the seed being dead and unable to germin ate a common enough thing when he gets his seed from a grain dealer If then all the seed germinates some of the plants will be overcrowded and it may be desirable to thin out a few in order to give the rest more room this process is not common in the provinces On the other hand with some crops it is possible to fill up blanks that have been made by the seed failing young wheat seedlings for instance can be taken from places where the field is overcrowded and planted in the blank spaces but this requires much minute labour and it is always doubtful whether the process pays its expenses In other cases blanks can be filled by sowing more seed in holes opened by hand or with the khurpi this too is a rare practice but it may pay with crops such as maize and cotton where the number of plants in a field is comparatively small and the loss of even a few may make an appreciable difference in the yield of the plot

Thick and thin sowing

The spacing of the plants in the field has a marked effect on the way in which they develop As a general rule plants sown close together grow taller and with fewer branches than if the spaces between them were greater consequently plants which by habit throw out several stems or branches each of which bears flowers and seed require more room,

and therefore are sown more thinly than those that have a single stem with few branches or several stems growing up close together Arhar, for instance, may be sown very thinly along with juar, but if the season suits it it may grow so thick and bushy as to fill the whole field after the juar has been removed The commonest practical use of this principle is the sowing of juar for fodder when this crop is sown mainly to produce grain, not more than ten or twelve pounds of seed go to the acre, but more than twice this quantity is sown for fodder, the plants are crowd ed close together and grow to a great height, so that the quantity of fodder gathered from an acre is much increased while (if they are allowed to form grain at all) the heads contain much less grain than where each plant has had a greater space Again hemp which is grown for the fibre contained in the stalk is sown very thickly so that the stalks, and therefore the fibre they contain, may be as long as possible On the other hand, low, bushy crops like gram are sown thinly, so that the individual plants may not be crowded, and stunted in their growth

Quality of seed.

The quality of the seed is a most important question In the ordinary course of things some of the seeds produc ed by a plant are in some way defective, that is, either they will not germinate at all or they will produce inferior plants which will yield at most a reduced quantity of inferior seed, and on the other hand, some seeds will produce plants of exceptional health and vigour The proper choice of seed is therefore an important matter in an ordinary lot of seed it is not unusal for ten per cent or more to be bad, this would mean a corresponding reduction in the outturn, but as we have seen the cultivator usually endea vours to protect himself from the loss by sowing more seed than is actually needed. This course involves a certain amount of waste due to faulty spacing as there is no

certainty that the bad seed will be evenly distributed, but it minimises the loss at the cost of the extra seed required In some cases, too, the loss can be further reduced by transplanting, but undoubtedly the best course is to sow good seed, and it is a course which the cultivator adopts when he can.

Seed supply.

It must be remembered that the ordinary cultivator can not go into one of a number of shops and choose the seed that he thinks will suit him if he is fairly prosperous, he will have saved his seed from the previous year otherwise he is dependent on the grain dealer who finances him Now a cultivator may either take only the best seed or he may take all that is not bad The former course which is usually called seed selection, will in ordinary circumstances lead to a gradual improvement in the crop, the latter will prevent a gradual deterioration

Seed selection.

Seed selection is commonly practised over large parts of the provinces in connection with certain crops Its action is based on the great principle of inheritance, that plants tend on the whole to resemble their parents Thus if a cultivator picks out, say, the fifty finest plants in a field and saves their produce for seed, he can be confident that the plants raised from this seed will, on the whole, be at least as good as the parents. The term "finest' which has just been used means most suited to the purpose for which the crop is grown if it is a grain crop, the finest plant is ordinarily that which yields the greatest quantity of good grain The crop of which seed is most commonly selected is juar if you see a cultivator in the central duab starting to thresh his juar, you will most probably see that he puts aside a small pile of the largest heads, and he will tell you that he is saving these for seed Similarly for

maize the finest cobs are often set aside and I have been told that some of the western cultivators even chose wheat seed in the same way The process is certainly desirable in all cases but as with so many other desirable processes the question arises whether it is worth the labour The labour depends on the ease with which individual differences can be recognised now juar and maize are just the crops where the ease is greatest for a man with any experience can see at a glance which heads or cobs are the best and he can do the selection on the threshing floor as juar has only one head and country maize not (as a rule) more than two cobs to the plant With wheat on the other hand where the productivity depends so largely on the number of ears to the plant the choice must be made in the field while the plants are standing and anyone who cares to try the experiment will find it a matter of considerable difficulty to pick out the best plants even in a half acre field With crops such as peas or urd again the plants are so much intertwined that selection becomes almost impossible These facts explain the apparent anomaly that many cultivators select from such inferior crops as juar while they do not select from wheat and further explanation is to be found in the fact that men can afford to keep a few pounds of juar seed though they have to sell (or hand over to their bankers) the whole produce of their wheat Seed selection is thus limited not only by practical difficulties but by economic considerations

Seed rejection

The alternative to seed selection is to reject those seeds which are noticeably bad and sow all the rest Some of the most careful cultivators habitually hand pick their seed rejecting any seed that looks abnormal I have seen this done even with such a cheap crop as urd and a very laborious process it is A readier but not so effective

method is to pass the seed over a sieve, rejecting all under sized seeds (as small size as a rule indicates weak or defective seed) and this also is commonly practised, but many cultivators sow all the seed they can procure without separating out the defective seeds or impurities, taking in fact what is given to them though they appreciate highly an offer of better seed

Deterioration of seed stocks

Thus no improvement in the local agriculture is needed more urgently than increased facilities for obtaining good seed It must be recognised that under present conditions the chances are in favour of a progressive deterioration of the crops in those cases where the seed is advanced by the grain dealer A grain dealer receives at harvest a large quantity of wheat (for instance) some of which he will keep for issue of seed next season while the rest he will sell in the towns for consumption as flour Now the price of what he sells depends on its quality while in practice he can advance any quality he likes for seed It is not in human nature that the average dealer should keep his best wheat for sowing the ordinary man will sell the best and keep for sowing that which would command the lowest price in other words the process at work is the selection of the worst not the best seed and this process must lead to gradual deterioration The importance of this question to the country is obvious

The existing system of seed supply leads also to the mixing of several varieties in the field and with commercial crops such as wheat and cotton mixed produce fetches lower prices than could be obtained for pure varieties It is however little use for the individual to keep his seed pure if his neighbours will not do the same and the improvement of seed stocks is essentially a matter for co operative action so that a sufficient quantity of pure produce may be offered to tempt buyers to pay a fair price

Change of seed.

Another point of interest in connection with seed is that seed from the same stock sown year after year in the same locality tends in some cases to deteriorate in such cases it is a great advantage occasionally to obtain seed from some distance This of course is impossible for the ordinary cultivator, but the benefit is secured to some extent as a result of the periodical scarcities when local supplies become insufficient and large quantities of seed grain have to be imported from elsewhere The need is probably less important where pure strains are grown than where the seed is mixed

Introduction of new crops and varieties

Lastly a few words may be said as to the introduction of new crops or varieties It is as a rule of little use for a landholder or cultivator to sow a small plot of a new crop because it attracts so many enemies that it is likely to be a financial failure while if the produce is to be sold there is not enough of it to make a market A plot of maize, for instance sown in a locality where maize is not grown will attract so many birds and vermin that without fencing and constant watching there will be very little yield, again where a new variety of an existing crop is tried on a few small plots the process of cross-fertilisation referred to in chapter I will prevent its maintenance in a pure condition and will probably obliterate the very qualities that give it its superiority The introduction of new crops or varieties requires organised action by landholders and cultivators To begin with demonstration plots should be arranged in the villages concerned these should be controlled by the agricultural department, which can carry out the special precautions required in each case Then if the cultivators decide to try the new crop or variety arrangements have to be made that nearly all of them shall grow it, and

simultaneously steps must be taken to provide a market The process is by no means simple, and requires either the active co-operation of the landholders, or organised bodies of cultivators such as are now to be found in the co-operative societies

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Chapter VII—IRRIGATION

Introductory

The cultivator can conserve by proper tillage much of the natural water supply for the benefit of his crops, and there are some regions in the plains where the supply in ordinary seasons is about sufficient for his needs This is the case in most of the river valleys and also in a large part of the submontane tracts where the heavier rainfall and the drainage from the higher ground combine to keep the land sufficiently moist Over the greater part of the duab, however, irrigation is necessary to make the best use of the land in the rabi season, and it may also be required to tide over dry periods in the kharif

Sources of irrigation.

The first question is, where to get water, the second, how it can best be used The sources available are (1) canals bringing water from the great rivers, (2) local streams, jhils and tanks, (3) wells

We are not concerned with the construction or management of the canal systems, which are in charge of an expert department The water is laid on in a series of channels, according to the level of the country, from these channels, which are maintained by the department, it is led through the village by smaller channels constructed by the land holders or cultivators These village-channels are as a rule so badly designed and maintained as to cause very serious loss of water, and the consequence may be that cultivators cannot get the water which they need, and which

would reach them through a well maintained channel It is thus the interest of the landholders to see that the channels on their estates are properly maintained and that waste of water is avoided, and where the channels are of some length the advice of an officer of the Irrigation department should be sought and followed

Streams and jhils.

The use of local streams and jhils is largely governed by customs (which are as a rule recorded in the village papers) securing to different interests something like a fair share of the limited supply of water available In fact the limitation of the supply is the distinguishing feature of these sources they can usually be drawn on for late rice and for the first watering of the rabi, but in a dry season they commonly prove insufficient even for these purposes, and it is only rarely that they can be relied on for a second rabi watering In fact it may be said of these sources that the greater the need the less help can they give

Tanks.

The term *tank* has different meanings in different parts of India, and these must be clearly distinguished. In more or less hilly tracts, a description which covers part of Bundelkhand and smaller areas in Mirzapur, Allahabad and Agra a tank is a reservoir formed by throwing a dam across a valley or depression between two hills the reservoir so formed catches the rainfall on the hills, and water is let out from it to the lands lying at a lower level in addition the soakage from it keeps the land below the dam much moister than it would otherwise be, and ensures a supply of water in the wells. Reservoirs of this description are unknown in the duab, where the surface does not permit of their construction but somewhat similar results are obtained on a smaller scale by dams thrown across the drainage-lines to hold up water for the rice crop In the duab

a tank means simply an excavation in the level ground the earth excavated is thrown up round the edges, gaps being provided by which the surface drainage from the neighbouring land can flow into the excavation These tanks are not capable of assisting irrigation on a large scale They are usually shallow (as the cost of excavation increases greatly with the depth), so that the amount of water stored is not great, and it diminishes rapidly by evaporation in hot and dry weather Further, as with jhils tanks hold least water when most is wanted Tanks are however, by no means useless near houses they are most useful for watering cattle and for various domestic purposes and in ordinary years they can usually give a first watering to a certain amount of land, they cannot, however, serve as an efficient protection against drought The chief point to attend to in their construction is the nature of the soil the bottom of the tank should be a thick layer of clay which will, as we have seen, serve to keep the water from draining away it is often possible to dig a tank too deep and cases are known where in the attempt to increase the value of a tank all the clay bottom has been dug out and a sandy bottom left which held no water at all Such a mistake would not be made by a practical cultivator, but is not unlikely to occur when a tank is being made by an ignorant land agent.

Wells.

Finally there are wells, the most important source of all In parts of the country south of the Jumna the wells are sunk into rock and supplied with water through the cracks and fissures which they cross In this case depth is the chief need, and the people sink the wells as deep as they can afford But in by far the largest part of the province, the wells do not penetrate within many hundred feet of rock their supply is drawn from the subsoil, and the conditions under which water is obtained should be clearly understood.

If a hole is dug in the ground it will sooner or later reach a point where water begins to collect at the bottom the depth at which this occurs is called the percolation level, in the alluvium it varies between about 10 feet and 100 feet below the surface If the hole is dug deeper, water will collect in it and will stand at this level, and if the water is taken out, more will flow in until it has again reached the level

Such a hole constitutes a *percolation well* Wells of this kind are exceedingly cheap but they are very short lived as the sides soon fall in, and the supply of water which they yield is as a rule very small

The other kind of well is called a spring well We have seen in the previous chapter that below the surface of the ground there are large beds of saturated sand more or less enclosed in clay a spring well is one which draws water from one of these underground sand beds The well is sunk down to the clay overlying the sand and a hole is then driven through the clay bed the water rises through this hole and fills the well to the percolation level or there abouts, and as water is drawn out more comes in through the hole in the clay and this level tends to be maintained These wells have this advantage over percolation wells that the supply of water is ordinarily much greater, and that being stored at a greater depth from the surface it is less liable to loss from evaporation This greater depth, on the other hand, involves more expense in raising the water, while in many cases the well has to be lined to keep the sides from falling in The great value of these wells is that they can be relied on in years of drought when streams and tanks have dried up, and percolation wells are liable to fail It is of course conceivable that a severe drought should result in these underground supplies failing, and this has actually occurred over limited areas, but as a rule, though the percolation level may fall after a

drought, the well remains serviceable and the level rises again when wet seasons ensue

Lining wells.

We have just mentioned that the sides of a well may need protection it is the extent of this need which mainly determines the cost of making a well Lining may be required for wells of both kinds and the methods adopted in the two cases are generally similar Where the soil through which the well passes is throughout clay or stiff loam it may be possible to do without any protection, as the earth at the sides will retain its place even when wet Deep unprotected wells of this sort may last for a long term of years, but they will eventually wear out as the slow oozing from the sides and the splash of water spilt while being lifted tend to loosen the earth and make it fall into the well

It may, however, happen that the well has to pass through a bed of sand or light, friable loam, if this is left unprotected, the loose earth soon falls into the well, bringing with it the loam or clay which rested on it, and the well is spoilt Very ingenious methods have been devised by cultivators for preventing this injury the commonest is to protect the weak part of the well by a thick rope of twigs coiled round it arhar stalks and the coarsest high grasses are usually employed for this purpose Sometimes a hollow cylinder of arhar stalks is woven basket fashion and fixed in the weak place, sometimes the cylinder is built of pieces of wood pegged together, and sometimes the weak place is lined with bricks resting on a shelf or bevel cut in the well Cylinders of corrugated iron can also be employed they cost more than the other devices but last longer In the case of a percolation well a lining is usually required for a few feet at the bottom

If however the soil is sandy throughout, or if there are numerous bands of sand, the whole well must be lined,

Either the well may be dug in the usual way and then lined from the bottom with bricks uncemented or cemented only with mud, or a masonry cylinder (strengthened sometimes with iron rods or bands) is built up on a strong ring of wood or iron (called the curb) and gradually sunk by digging the earth from beneath it until the clay bed on which it is to rest is reached

There are many important points in this operation which we cannot deal with fully the practical work of sinking a cylinder must be carried out either by a professional engineer or by a practical builder who has experience of what has to be done One great danger is the use of bad mortar, which may lead to the cylinder breaking another is that it may be sunk crooked, usually with the same result

Conditions for spring wells.

Apart then from the use of good materials and the employment of careful workmen, the great point in undertaking the expensive work of sinking a masonry spring well is to be reasonably sure (1) that a bed of saturated coarse* sand exists at a reasonable depth, and (2) that it is covered by a layer of clay sufficiently thick to support the cylinder that will rest on it In popular language the bed of clay lying over the saturated sand is known as *mota*, and 'foundation-clay' is a convenient English equivalant Foundation-clay is generally, but not universally, met with in the greater portion of the well irrigated area in the Gangetic plain from Aligarh northwards its distribution is more irregular and further east there are numerous localities where the layer is too thin to support a well or is altogether absent In villages where wells are numerous the cultivators rarely or never make a mistake in locating the site of a well the localities which should be avoided

* If the sand is very fine, the water will not flow readily into the well

have been learned by experience which is carefully treasured up But in a locality where failures have been frequent or where there are few existing wells, cultivators dare not risk making a well which may prove a failure: hence these localities remain unirrigated and are liable to serious injury in dry years In all cases where the cultivators are doubtful whether a well can be sunk, it is advisable to begin by taking trial borings A boring is simply a narrow hole sunk in the earth the nature of the earth brought up is noticed and a person trained in the art can infer almost with certainty from these indications whether a well can be sunk or not This precaution should always be taken when it is desired to sink a well in a place where a cultivator is not willing to take the risk In some of the western districts the profession of well borer has come into existence in recent years, but in most parts of the provinces it is necessary to engage one of the borers who are provided by the Agricultural department and supplied with suitable tools

It occasionally happens that a well is a failure it goes wrong in sinking, or though properly sunk very little water flows into it In such cases is not necessary to pronounce the well useless a defective well can often be cured by an expert We cannot describe here all the defects that may occur or the remedies that should be applied and must leave the subject as one on which the ordinary person should be content to obtain expert advice Two common cases may however be mentioned Sometimes the foundation-clay is so thick that it cannot be pierced by the ordinary tools when this is the case, the tools used for trial borings are effective Again, when the supply of water is deficient, it may often be very greatly increased by sinking a pipe down to the next underlying sand bed boring tools can be used for this purpose also

Methods of raising water.

As a rule the water available is at a lower level than the field which it is desirable to irrigate, the only exception being where a canal flows above the level of the surrounding land, or in hilly country where a reservoir waters land below its embankment or where a stream can be carried in branches over sloping ground The first thing in utilizing the water is therefore to raise it to the required level The best means of doing this depends on the height to which the water has to be raised

For lifts of less than four feet, the ordinary implement is a closely woven basket held at the ends by ropes This is worked by two labourers who swing the basket into the water and then empty it at the higher level into the channel by which it is meant to flow This is hard work, and four men working by turns must be employed to each lift the merit of the system is that it involves little capital cost while its defects are (1) that a good deal of water falls back each time the basket is raised (2) useless work is expended on raising the basket (3) the process is slow When the rise is up to eight or nine feet two lifts have to be employed each with four men An alternative to the basket lift is the chain pump which consists of a series of discs on an endless chain passing over a wheel and through a pipe as the wheel is turned, the discs rising through the pipe bring up a constant stream of water A small pump of *this sort* requires rather less *labour than* a basket lift when properly fitted there is no loss by spilling nor is there any useless work as the chain and discs coming up are counterbalanced by the chain and discs going down This pump can do better work than a single basket lift but its efficiency is greatest between four and twenty feet as it can then replace two or more lifts Its drawback is its first cost (about fifty rupees) which puts it out of the reach of the ordinary cultivator It is

however extensively used by cultivators who have a large area under crops such as cane and potatoes, which require large quantities of water Two pumps of this kind can be geared together and worked by a pair of bullocks this forms a most efficient lift but the cost of gearing is so great that only the largest cultivators can afford it. A simpler lift (the Baldeo) is made on a different plan to be worked by cattle but its practical efficiency has not yet been fully determined and it is in use in only a few places

Canals are usually so planned that the lift does not exceed eight or nine feet, and this is the usual limit also with jhils and tanks though in special cases water is raised from these sources by three four or even five successive basket lifts For shallow percolation wells (say six to fifteen feet deep) there are two common lifts the *charkhi* and the *dhenkli* These are simple arrangements for lifting a jar of water and counterpoising the weight of the jar, and can be understood at a glance For deeper wells it is usual to raise the water in a leather bucket drawn by cattle walking down an inclined plane For lifts over twenty feet no cheap lift has yet been devised which can compete with this indigenous system. The inclined plane is worked on different methods in the east and the west of the provinces in the west two pairs of bullocks are used to each lift one pair coming up to the well while the other pair raise the bucket while in the east the work is done by a single pair The western system (known as *kili*) saves time and is less severe on the bullocks which do not undergo a sudden jerk as the empty bucket is returned to the well the eastern system (*lagor*) involves less capital expenditure on bullocks and is therefore more suited to the means of small cultivators

The form of lift known as the Persian wheel is in common use with wells in the extreme north and extreme south of the provinces, but is unknown in the intervening

country It consists of a rough frame work, working in the mouth of the well with an endless string of earthen pots hanging on it as the drum is turned by a rough wooden gearing worked by cattle the full pots come up out of the water and empty into a trough This arrangement appears to be less effective than the inclined plane but it is suited to the particular conditions of the tracts where it is found

There is a wide scope for the employment of mechanical power—preferably oil engines—in raising water from the rivers and the larger jhils The actual cost of raising water by an efficient engine and pump is very much less than that of the indigenous methods but to secure economy a certain minimum supply of water must be kept up This method therefore is beyond the reach of individual cultivators, but can be profitably adopted by groups of cultivators or by individual landholders Probably some wells also would yield a sufficient minimum supply to justify the use of an engine but in this case there is the risk that the foundation clay may collapse if too much water is drawn, and landholders should obtain expert advice before deciding on an installation

Application of water to the land

The proper application of water to the land is a matter requiring much experience and judgement, and also a certain amount of luck No rules can be given for judging when a field requires water and a cultivator is often tempted to withhold water for a few days in the hope of rain If the rain does not come, the growth of his crop is injured but, on the other hand if rain comes just after irrigation, some of the land may get an excessive supply, and at least equal injury result

The amount of water required and the number of waterings vary with the crop and with the soil Particulars

regarding the needs of each crop will be found in the detailed description given further on as regards the soil, it will be remembered that plants require a continuous supply of water, adequate but not excessive Now, as a field can only be irrigated from time to time, it is obvious that its soil will be sometimes rather too wet and sometimes rather too dry for the best possible growth hence an occasional light irrigation is desirable in preference to a single heavy soaking, but the cultivator is a busy man and must attend to all his land in turn, and in practice he arrives at a rough sort of compromise, giving perhaps rather more water on fewer occasions than is desirable Again it is obvious from what we have seen regarding drainage that a well drained sandy soil will require far more water than a rich loam to keep it in condition, in fact the very sandy soils require so much water that they are practically never irrigated On the other hand, the heaviest clays are seldom or never irrigated in the cold weather as the effect of watering these is to waterlog the surface Between these two extremes the cultivator regulates the amount of water to the best of his ability so as to give the plants the greatest chance of favourable growth the practice of the skilled cultivator cannot be improved in this respect In one point, however, practice is frequently defective, for when canal water can flow on to the lands, too much is very often used at one time Where water has to be raised the cost and labour of raising it ensure that there is no excess but when it flows freely, less care is taken and the lower parts of a field are apt to get swamped

Another point of importance is to see that each part of the field gets its fair share of water This is usually effected by dividing the field into compartments by low ridges of earth (known as *kiari*), as soon as the seed has been sown The water is then allowed to run into each

compartment in turn till it is sufficiently moist Obviously the smaller the compartments the more evenly can the water he distributed but, on the other hand smaller compartments involve more labour both in construction and in watering and here again the cultivator effects a compromise *The most valuable crops get the smallest compartments* as we can see if we compare a poppy field with a barley field and the greater the cost of raising water the smaller are the compartments, so that generally speaking the size of the compartments is smaller in well tracts than in canal tracts, and within canal tracts is smaller for lift than for flush irrigation

Relative value of canals and wells

The question is often asked whether well or canal irrigation is best Now there is no doubt that for all ordinary crops canal irrigation is easier consequently canals will as a rule supersede wells where they come into competition In special cases however wells may still be preferred, the reason being that the water contains some valuable plant food. This is specially true of wells near houses which contain the substance known as saltpetre composed of potash and combined nitrogen this is an admirable manure for most crops especially for tobacco and so we find that tobacco is where possible irrigated from such wells It must not be supposed that canal water contains no plant food the fine silt which it carries contains a certain amount of mineral plant food while combined nitrogen is also present derived partly from the rain water and partly from organic substances which have fallen into the water and decayed But the manurial value of canal water is nothing like that of a well very rich in saltpetre though it may be equal to that of a well in the open country

To sum up in the practice of irrigation as in tillage the average cultivator has little to learn His success is

conditioned by the capital he can command, and for want of capital he often has to put up with an inadequate supply of water and with inefficient means of raising it to the surface It follows that the greatest benefit a landholder can confer on his estate is to ensure an efficient water supply for all land where irrigation is possible

Note to Chapter VII

An immense mass of information on wells will be found in the papers relating to the construction of wells for irrigation, published in 1883, by the College Press at Roorkee The theory of wells is concisely explained in "The Manual of Irrigation Wells" by Mr E A Molony (Allahabad Government Press) For a discussion of the wider principles of irrigation the reader may be referred to the Report of the Irrigation Commission of 1901—03

CHAPTER VIII—MANURING

Supply of mineral plant food

As we have seen in the first chapter, all crops take some plant food from the soil, so that in process of time the mineral plant food must decrease in quantity But the reserve supply is so great and the amount consumed is so small that this question is not of immediate practical importance in the case of ordinary cultivators further little of the mineral plant food can be absolutely lost as neither potash nor phosphoric acid can pass away into the air, and therefore these substances return to the soil in ashes, excrement or decayed matter so long as the produce of the land is consumed on it Where however, the produce is exported the land is certainly impoverished and to this extent the provinces lose mainly by their export of oil seeds and of bones, the latter containing large quantities of phosphoric acid Under the existing conditions, however these exports must continue though they undoubtedly represent a sale of part of the capital of the country, the cultivator does all he can when he sees that the ashes or refuse of whatever is consumed goes back to the land

Supply of combined nitrogen.

As regards combined nitrogen the position is different. We have seen in the first chapter that the stock present in the soil at a given moment is probably of less importance than the conditions for bacterial activity but there is no doubt from the practical point of view that the utilisation of all nitrogenous manures available in the village is a matter of fundamental importance The main substances which the cultivator has at his disposal are (1) human excrement, (2) human urine, (3) excrement of cattle, (4) urine of cattle (5) dead leaves, stalks wool, hair, and household refuse generally

Use of human excrement.

The disposal of human excrement and urine is governed by the social habits of the people and there is no near prospect of any regular system of sanitation being introduced in the villages As a matter of fact, however, much of the excrement does go to enrich the soil of the fields close to the houses and even the portion which is deposited on waste spaces in the village is not wholly lost, as some of the products of its decomposition find their way into the underground water and so into wells but it would be a distinct benefit to agriculture as well as to sanitation if public opinion should prevent the pollution of the village site and require all excrement (solid and liquid) to be deposited in the fields In towns which are too large for the population to be within easy reach of the fields, the excrement is removed by sweepers and either sold to those cultivators whose caste rules permit them to handle it, or else buried in the ground The latter course is usual in the neighbourhood of the larger towns ordinarily a pit is filled with excrement and then covered with earth after sufficient time for the putrefactive processes to go on, the pit will contain a dark substance which can be handled

without offence and is known technically as poudrette it is an exceedingly valuable manure containing large quantities of combined nitrogen and is used chiefly for the more expensive crop such as potatoes vegetables and sugarcane though it can be used profitably for the ople crops also This system does not however save all the combined nitrogen of the excrement the aggregation of large masses with insufficien access of air is no the most favourable condition for the bacteria which would effect putrefaction in the most desirable way and considerable quantities of combined nitrogen escape in the form of ammonia the pungent smell of which (flavoured by other products of decay) is a permanent feature of the localities where excrement is buried. An alternative system which is pursued in many cantonments is to bury the excrement in very thin layers in shallow trenches and to cultivate the land as soon as putrefaction is complete. This system which is to be preferred on sanitary grounds is also effective from the agricultural point of view as the loss of nitrogen is much less it requires however a very large area to deal with any considerable amount of excrement and it is not wholly satisfactory in heavy clay where the soil is not easily penetrated by air The best results are obtained with light sandy soil

Various other methods of sanitation are now on their trial the common feature of which is that the excrement is caused to putrefy not in earth but in water so that the combined nitrogen dissolves in the water which can then be used both for irrigation and manuring It *must be recognised that the disposal of excrement* in cities and towns is primarily a question of sanitation, the agriculturist has merely to make the best use of the material which the sanitary authorities provide

Excrement of cattle.

Next as regards cattle excrement The value of cow dung as a manure is well known to the cultivators, and if they burn the dung instead of applying it to their land it is mainly because they cannot obtain other fuel, to a certain extent also cowdung has special advantages as fuel in that it keeps alight for a long time with little consumption Whether landholders can profitably take steps by providing other fuel to save the cowdung for the land is a question the answer to which depends on the resources of individual estates, it may be noted, however, that a custom frequently prevails under which so many months dung is kept for fuel while the balance is set aside for manure, and that of course the ways of individual cultivators differ enormously the good cultivator is careful of his dung pit

Dung-pits.

The best results are not obtained by putting dung on the land while fresh, it is better to keep it together till it has rotted, that is, till the combined nitrogen has come into a state where it is available for plant food. The method of storing is most important, as bad storage may lead to considerable loss, and the cultivators of these provinces are perhaps less skilful in this than in most branches of their work To begin with, the dung pit should be out of the reach of rain, as water will wash out of it such portions of the combined nitrogen as have become ready for plant food the pit should therefore be protected by some sort of a roof, and it should have low walls to prevent surface water flowing into it Secondly, much depends on the conditions under which putrefaction takes place we must regard a dung pit as swarming with many different kinds of bacteria or small living beings, each of which wants to feed on some part of the contents, some

kinds of these living beings will waste the combined nitrogen, while others will put it into a proper form, each kind will thrive best under certain conditions of moisture, temperature and aeration, and the cultivator's object should be to keep his dung at such a heat and so supplied with air and moisture that the beneficial bacteria will thrive and multiply and the harmful species will find it difficult to exist There should not be too much air inside the heap of dung, or in other words, it should be fairly closely packed, the heap should not be too dry so that in hot weather it is desirable to sprinkle it occasionally with a very little water If these conditions are fulfilled and especially if the free access of water is prevented in the manner described above, all that the cultivator can do will have been done

Urine.

If much of the cowdung is lost to the land, the case is even worse with the urine, hardly any of which reaches its proper destination unless actually voided in the field or soaked up in the dung used for manure It is not desirable to collect the urine as a liquid and put it while fresh on the land, and if desirable it would not be practicable In most countries cattle have litter (straw, leaves, &c) put in their stalls for warmth much of the urine is soaked up by this, and as the litter when foul is thrown on to the manure heap the urine reaches its proper destination In the greater part of these provinces the cattle have to do without litter as the straw is needed for fodder, and what dead leaves are available are used for fuel the cattle therefore when not at work stand on bare earth, into which the urine soaks and is lost Much of it can however be saved very cheaply and effectively wherever the cattle are kept under a roof the top layer of the floor should be dug out at intervals and the earth added to the manure heap, while fresh earth is put on the floor This

practice is followed by a few cultivators and its more general adoption would be a distinct gain

Other refuse

As regards the other refuse of the house it is usually pitted along with the dung and the organic matter rots in the same way while the mineral matter contained in the ashes is unchanged The mixture so obtained is spread over the field to be manured and the field is then ploughed so as to mix the manure with the soil before the seed is sown Occasionally however dung is scattered in small pieces over land on which vegetables or valuable crops such as poppy and tobacco have been sown

Urine earth can be applied either as ordinary manure or else scattered over growing crops It gives very good results when used as a *top-dressing*, that is applied to a growing crop

Feeding cattle on the land

It is not absolutely necessary to keep the dung and urine near the cattle shed and then carry it to the field in many countries it is usual to feed the cattle on the land to be manured and leave their dung and urine to work into the soil thus fodder crops such as turnips are largely fed on the land In the duab this practice does not prevail in many parts the cultivator cannot spare any part of his land solely for fodder crops but must grow crops which will feed himself and his family as well as his cattle while in the west where the larger holdings allow of the growth of fodder crops the need for tilling the land as soon as the fodder can be cut the risk of theft if valuable animals are left out at night and the want of fencing combine to make it better to carry the fodder to the house but it is a common practice in the eastern districts to keep sheep on land that is to be put under sugarcane The sheep which naturally feed very closely

eat the stubble and weeds that are on the land and leave their dung and urine on it in other words they are employed to turn the weeds stubble and any other food they can pick up into manure containing its combined nitrogen. That the cultivator considers this a benefit is shown by the fact that he makes a small payment to the sheep-owner for the use of the sheep

Special manures.

The cultivator has in addition to dung urine and miscellaneous refuse a few special manures at his disposal One of these is saltpetre which is very valuable as containing both potash and combined nitrogen in a form which can be taken up directly by the plant Where this substance is available it is used in small quantities as a top-dressing for valuable crops It is found mixed with other substances in places which have been inhabited for a long period. In such cases the ground always receives a large quantity of combined nitrogen especially in the form of urine this is worked up by the bacteria in the soil and unites with the potash present there and eventually makes its appearance as a white incrustation on the surface of the ground. This is of course mixed with earth and the mixture is used under the name of *nona mutti*

Another special manure is the substance known as cake which remains when oil has been pressed from seeds In most cases this is too valuable to be used as manure as it is an excellent cattle food, indeed til-cake is occasionally eaten by human beings but castor-cake has certain medicinal properties which prevent its use as a cattle food. Now we have seen that in oil seeds there are two principal classes of substances (1) the oil and (2) the substances containing combined nitrogen When the oil has been removed the residue contains a great deal of the latter substances and makes an admirable manure for such crops as the better kinds of sugarcane The quantity available

for this purpose is of course small Other cakes are also available on a small scale the best of them is that which is obtained when the oil has been pressed out of the seeds of the *nim*.

As has been said above, bones contain a great deal of phosphoric acid and also a certain amount of combined nitrogen, they have therefore a considerable value as manure Unfortunately however, these substances are not in a condition to be used by plants, and bones decay very slowly In many countries they are made into an excellent manure by treatment with sulphuric acid, the product being known as superphosphate or as dissolved bones The cost of sulphuric acid in these provinces renders this treatment commercially impossible, and the only way known of utilising the bones is to grind them into powder before putting them on the land This grinding accelerates the changes which are required to make the bones readily available, but the powder must be very fine to be of real value, and grinding is expensive Many castes too have a prejudice against handling bones, while the ordinary alluvial soils contain sufficient phosphoric acid for the growth of ordinary crops The use of bones is therefore likely to develop very slowly, if it develops at all

In most countries minerals containing potash or phosphoric acid are largely applied as manures, but in the duab there is as a rule little need for these, and their use is economically impossible they do not exist on the spot and the cost of bringing them from long distances is prohibitive

As regards the distribution of manure over the various parts of a cultivator s holding, something has been said in the chapter on soils, and we shall return to the subject when dealing with the management of a holding

Note to Chapter VIII.

Detailed descriptions of various methods of saving dung and urine will be found in *Bulletin* No 14 of the Agricultural Series, published by the Superintendent of the Allahabad Government Press A good summary of what is known regarding the rotting of manure will be found in "Agricultural Bacteriology" by H W Conn (London, Rebman) 'The Farm Manual' published by the Superintendent of Government Printing at Calcutta may be referred to for an account of the shallow trench system of disposing of refuse

CHAPTER IX—HARVESTING PAYMENT OF RENT, AND DISPOSAL OF PRODUCE

Time of harvesting.

The right time to harvest a crop cannot be ascertained by reference to rules, but can only be learned by experience A crop has to be harvested as soon as it is ripe, since a ripe crop standing in the field very soon deteriorates some of it is stolen, some taken by birds or animals, or knocked off the plant by wind or rain, while in some cases, especially sugarcane, the composition of the produce undergoes rapid changes Ripeness in fact means that the produce has just reached the stage where it is most valuable for the cultivator's purposes

Harvesting of some crop or another is going on almost throughout the year from August to May In August indigo is being cut and the first of the small millets are ripening By September the maize harvest is in full swing and the earlier rices are being cut the main kharif harvest (millets, pulses, cotton and finally, late rice) goes on from October to December by which time the earliest sugarcane is ready for pressing This operation continues till February or March, and as soon as it is over the earliest of the spring pulses are ready to be gathered, then follows the wheat and barley harvest, which lasts till about the end of April Meanwhile all sorts of minor crops have been gathered potatoes come in during February, a large

variety of melons cucumbers and pumpkins at intervals from April till October the hot weather millet (known as either *chehn* or *sawan*) during May and June and the mango crop in the same months The rabi ripens much earlier in the east than in the west there is nearly a full month s difference between Benares and Meerut The prolonged cold wea her in the west accounts for the differ en e as up to a certain point plants mature quicker the higher the temperature In the kharif season on the other hand the crops usually mature earlier in the west where the rain of September is as a rule less copious than in the east

Methods of harvesting

There are two main methods of harvesting besides numerous special methods applicable to particular crops Where the ears of grain are comparatively few and con spicuous it is usual to cut them off and get out the grain separate from the rest of the plant This is done in the case of juar bajra and maize in the first two the ears are placed on a bare piece of ground and cattle driven round and round over them the feet of the cattle gradually knock the grain out of the ear and in time (for it is a tedious pro ess) all the grain is separated As soon as this point is reached the grain is winnowed this is done by lifting up the stuff that has been trodden and letting it fall in a current of wind the grain is heavy and falls straight to the ground while the fragments of the heads are lighter and are blown a little distance off The grain thus accumu lates in one heap and the broken heads or chaff in another

In the case of maize the cobs (as the heads of grain are called) are not trodden out as this would damage the bulky seed but beaten with sticks till the grain falls off This method of beating is also practised with some other crops either the ripe plants are beaten with sticks or they are

themselves beaten against the ground till the grain falls out

With most of the crops that produce large numbers of heads of grain, the whole crop not the heads only, is put on the threshing floor and trodden out by cattle, and the grain is then winnowed out by the method just described This is done with wheat, barley, most of the pulses, and various other crops Winnowing, which looks so simple, really needs a good deal of skill in order to judge the best height from which the grain should fall and the speed of its descent Given this skill it is a most efficient process, and the grain is left in a heap wonderfully free from chaff and dust the chief drawback is that sometimes in November and December the wind fails, and it becomes necessary to create a current of air by waving a blanket or cloth, failure of the wind need hardly ever be feared in March or April

The method of harvesting naturally affects the state in which the rest of the plant is left When the ears are trodden out separately the plant is left unbroken, in some parts of the country the juar and bajra stalks are left standing in the field* till wanted for fodder, while elsewhere they are cut and stacked in the field or stored in the house. Before being used for fodder they are chopped up into pieces of half an inch to an inch long, which are easier for the cattle to eat than the long stems Maize stems when dry are very innutritious and are used mainly for fuel, but the green stems are given to cattle, usually mixed with juar Where the whole crop has been trodden, as in the case of wheat, the plant is left broken into small pieces which can be given to cattle without further preparation

The special methods of harvesting are employed mainly with those crops which are grown not for food but for some

* This is a most objectionable practice because the stalks harbour insect-pests as will be explained in the next chapter

other product Thus the whole indigo plant is cut when green and steeped in water to extract the dye the cotton pods are picked separately by hand and the fibre removed from the seed by a pro ess known as ginning hemp is soaked in water to rot the stems which are then beaten till the fibre is freed the heads of the poppy are lanced and the opium that oozes out is scraped off the leaves of the tobacco plant are picked and dried in the sun and so on Again we have seen that some food crops are grown not for the seed but for the reserve of nourishment which the plants store under ground in these cases the crop is harvested simply by digging up the store when it is fully accumulated as with potatoes radishes yams and various other vegetables Sugarcane is treated by a separate process the juice is pressed out of the canes as soon as they are cut and is boiled down till the whole is obtained as a solid or a thick liquid These special processes will be described where necessary in connection with the crops to which they are applied

Defective methods

It is important to remember that these methods of harvesting which cultivators have worked out for themselves in the course of centuries are adapted primarily to their own needs since there was no possibility of exporting ordinary produce until quite recently It is therefore only to be expected that their methods occasionally produce results that are not welcomed in European markets This is least noticeable in the case of grain all that anyone wants is to have his grain unbruised and free from other substances and the cultivator s methods give this result very fairly Indian wheat had until recently a reputation for being full of dirt but Dr Voelcker s enquiries showed that most of this dirt did not come from threshing floor but was added afterwards by way of adulteration and since English buyers have insisted on a high standard of purity the

standard has been maintained without difficulty On the other hand, no European market would look at the stuff that the cultivator turns out as sugar his fibres are sometimes so badly prepared that much of their value is lost, and the flavour of his ordinary tobacco is not appreciated even by his richer neighbours The question of adapting his methods to the tastes of a wider market is of great practical importance but can hardly be discussed in this place the best chance appears to be the multiplication of collecting agencies under skilled supervision which shall take over the raw produce and work it up for the market The great spread of cotton ginning mills in recent years indicates the direction which this movement may take in future

Disposal of produce.

The cultivator has usually to dispose of most of his produce as soon as it is harvested When possible he stores enough food to last his family till the next crop is ripe and to meet his expenditure on wages, and he usually keeps his small supply of hemp fibre, a little of his cotton, and so on, but he has to sell a good deal to pay his rent and to get enough money for his miscellaneous expenditure Sometimes, however, he is heavily in debt and has to hand over nearly the whole of his produce to his creditor, who then allows him enough to keep his family alive till the next harvest Cultivators in this position have no interest in the disposal of their crops beyond keeping whatever they can out of their creditor's hands The man whose produce is in his own hands either sells it to a trader living in his village or takes it to the nearest market, but there are certain crops which are commonly grown under another arrangement, namely, indigo, sugarcane and poppy The manufacturers of these products are naturally anxious to assure a supply of raw material for the year, and a system has grown up under which they assure themselves by giving

advances of money at seed time to cultivators who undertake to supply them with the produce of a certain area at a fixed price Theoretically this is a good system the cultivator is assured beforehand of his market and the manufacturer of his raw material, while the former gets a cash advance just when he most needs money, and where the parties can trust each other the system works well in practice This is seen most conspicuously in the case of poppy, where the advances are given by Government, and in the neighbourhood of some indigo factories held by upright and considerate manufacturers But where the manufacturer is untrustworthy (as in the case of many of the smaller indigo concerns, and a large number of sugar boilers) the practical result of the system is evil the accounts are manipulated against the cultivator and as soon as he can be shown to be in debt at the end of a season he may be forced by threats of legal proceedings to grow a larger area than he can manage, and often to accept a lower price He thus falls into the power of the manufacturer who takes good care to maintain his hold over him

One practical evil of the system when worked in this way is that it interferes with a proper rotation of crops thus while the indigo business was prosperous indigo was sown far too often in many fields, and the soil injured in consequence so, too, there are parts of Rohilkhand where the land is forced under sugarcane so frequently that it has become impoverished, the cultivator is bound to grow a certain area, for he is ordered to do so by the manufacturer who is his creditor, and as he cannot enlarge his holding he must use some of his land that bore the same crop quite recently, when, if he were a free agent, he would certainly grow something else It is a remarkable fact that the decline in the cultivation of indigo due to the fall in the price of the dye was a source

of intense satisfaction in many villages that formerly put a large area under this crop

The necessity for the prompt sale of produce is undoubtedly an evil Just after harvest so many cultivators are in a hurry to sell that the buyers are able to lower prices, and the seller loses accordingly, had he enough capital to enable him to hold his produce for a few weeks, he could get substantially higher prices. But this evil is not confined to these provinces, but is to be found wherever small holdings are common and the holders are not organised, one of the most valuable results of organised co-operation in agriculture is that it enables cultivators to wait for a favourable market

Payment of rent.

As we have indicated above one great cause of early sales is the need for paying rent the landholder is usually in as great a hurry for cash as the cultivator In most parts of the provinces rents are calculated and paid in cash, and may vary from one rupee an acre for the worst bhur and the more precarious ricefields to from twelve to fifteen rupees for the rich gomd round villages, and to fifty rupees or more for market gardens near the larger cities The rents of course depend largely on the competition for land, in tracts such as Bundelkhand and the unhealthy Tarai, they represent a much lower share of the produce than in the central and eastern districts, where every patch of fertile land has many claimants and the difference between the two cases is seen not only in the amount which the landholder asks for but in the amount with which he is contented. Where tenants can be found easily, a man who does not pay promptly can be got rid of and replaced by a more satisfactory tenant, but in the backward tracts the land is waiting for cultivators and ejectment is very rare, hence the tenants pay on the whole a much lower proportion of the demand than in the

districts that are thickly populated, they claim more consi deration for any accidental injury to the crops, and if the landholder insists on full payment, they are apt to leave the rent unpaid throw up their holdings and take fresh land in a neighbouring village Thus the real pressure of rent in such tract is even less than is suggested by the amount demanded which is in fact an ideal only to be realised in the best of seasons

Cash rents are however not universal In some large tracts and numerous smaller areas the rent is calculated by some system that makes it depend on the amount of the produce These systems are usually found where the pro duce is precarious the landholder has then to share the risk of loss in order to get the land cultivated The simplest of these systems is actual division of the produce *(batai)* the grain on the threshing floor is weighed and the land holder's share handed over to him the share varying from one half to one fo irth or even less according to the risk in volved in cultivation and the strength of the tenant's posi tion The drawback to this system from the landholder's point of view is the risk of fraud the risk is least where he lives in the village and collects his own rent while when he lives at a distance and employs an agent his share is often con iderably reduced before it reaches him A variation of the system more favourable to the landholder is the method known as *kankut* under which the amount of the standing crop is estimated and the landholder's share valued at a fixed rate the value being payable in cash Here too the landholder is liable to be cheated in the estimation but on the other hand he is often able to insist on a rate much more favourable to himself than he would get if he took the produce to market

These are the commonest systems of calculating rent, the others are much localised and need not detain us though we may mention that in which the rent of a field

varies from year to year with the nature of the crops sown on it, a plan that looks cumbrous but is apparently suitable to the tracts where it is to be found In all cases, except that of actual division of produce the cultivator is forced to sell soon after harvest to pay his rent and even where produce is divided the landholder is apt to sell his share at once, so that the objectionable flooding of the market is not appreciably reduced

Note to Chapter IX

The rental systems prevailing in the provinces can best be studied in the earlier settlement reports there seems to be no work dealing with this interesting subject as a whole

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Chapter X—PLANT DISEASES AND PESTS

Growing crops are exposed to injury from an immense variety of living things, we may conveniently classify the living enemies of crops as either animals insects fungi or weeds, and we may say roughly that the smaller the individual enemy, the more numerous it is and the greater injury does it cause

Animal pests

Among animals pests there is first man who steals the melons, the maize cobs and the fruit, and occasionally reaps part of some one else's field. Then there are the cattle which are apt in their hunt for food to graze on the growing crops and the monkeys, which religious sentiment still allows to congregate in such numbers that they do a great deal of damage in the fields Of wild animals, pig are probably the worst they live usually in the low lands but come into the cultivated ground at night hunting for the roots which constitute their favourite food, and do much harm by rooting and digging among the crops Deer feed on growing crops, and do nearly as much damage with their feet as with their teeth jackals make a specialty of maize, pulling off the cobs, and also eat sugarcane

porcupines dig up seed potatoes and other root crops, and in some places are ruinous to young trees, rats construct extensive burrows in the fields, and sometimes cause considerable loss by eating the produce or by storing it in their burrows, squirrels and some birds pick the ripe grains out of the crops, and in fact there is hardly an animal that has not to be guarded against

Remedies.

Watching is the great preventive of all attacks of animals, for the fields are almost universally unfenced and the country is so open that they can go where they like As soon as the crop comes to a dangerous stage, a shelter is put up in the field often raised high above the ground and the members of the family take it in turns (sometimes with assistance from labourers who are past other work) to occupy these shelters scare away the birds and animals and keep a look out for thieves Where wild animals are numerous some one in the village often possesses an ancient gun which is fired occasionally rather to frighten than with any intention of killing, and the liberal grant of licences for such guns is the only way of helping the people living near forests or riverside jungles, care being of course taken that the guns are such as to be unfit for use by criminals

Monkeys cannot be killed or injured, as they are sacred to most classes of Hindus, but when they increase so much as to become an intolerable nuisance, an expert is occasionally hired to trap them and take them away to an island or let them loose on the far bank of a river

For field rats the most effective remedy is to irrigate the field drowning some and driving the rest to shift their quarters Musahars or men of some equally low caste are occasionally employed to catch the rats, but when a field is badly infested, nothing but a thorough flooding seems to have much result.

a fence along the edge of a forest so as to keep animals off a large area of cultivated land Some years ago Government fenced in this way part of the Agra district which was going out of cultivation owing to the inroads of wild cattle from an adjoining state the operation is however very costly and can be recommended only in exceptional cases

Birds.

It is important to know that all the birds seen in the fields are not enemies Those which live exclusively on seeds or fruit are enemies as a rule, but those that live on injurious insects are indispensable to the farmer, and if their numbers are seriously reduced the insects on which they feed may increase to an extent that involves enormous loss, insect eating birds should therefore be protected and encouraged in any way that may be possible Recent investigations have shown that the great majority of the birds commonly seen in the plains are beneficial to the cultivator

Insects

This brings us to the second class of pests—the insect Not all insects are obnoxious for, as we have seen in a previous chapter, some of them are indispensable to the proper fertilization of the plants, and there are some that live on other injurious insects, but the number of insect pests is very great They have not all been studied in detail, and all that we propose to do is to describe a few of the commonest and most injurious

(1) Many *caterpillars* do a great deal of harm by eating the leaves off the growing plants or boring into the unripe seed pods and eating the seed The commonest perhaps is the one known as *chheda,* which is to be found attacking the pods of gram peas and arhar at the end of a wet cold weather His ravages are not very obvious while the crop is on the ground, but when the pods are opened

the seed is missing, and what looks like a good crop may give a very poor outturn. There are numerous other caterpillars, nearly all of which seem to thrive in wet weather

(2) The *borers* do great harm to juar and sugarcane Certain moths lay their eggs on the young plant, and the grubs coming out of the eggs bore into the shoots and then settle down there, feeding on the nutritive material which the plant is building up for its own use The most important measure to be taken to reduce their number is the destruction of roots or stubbles in which they can live during the interval between one crop and the next The borers are known by various names in different places, *ar*, *dhola* and *ghiran* being perhaps the commonest

(3) Plant lice (aphis) are another common pest, they are familiar on rose trees and other garden plants and in the field are commonest on rape or mustard When the weather has been damp in January or February every plant of rape in a field may be seen swarming with these small, green insects they suck the sap out of the plant and thus abstract the material that should go to form the seeds This aphis is usually known as *mahun* It is kept under control by lady birds, which can usually be seen attacking it on the plants

(4) With these may be compared the rice sapper (known as *gandhi*), an evil smelling fly that settles on the stems of the rice plants and sucks the sap out of them

(5) In the same way a sort of fly attacks the buds of the mango tree in damp cold weathers The attack may be detected by the shining sticky stuff that exudes over flowers, this is the sap running out through the hole bored by the pest and where it has escaped hardly any fruit sets

(6) A pest that has appeared recently is the potato moth the larvae of which bore into the plants and also

into the potatoes while stored, and make a large proportion of them unfit for use

(7) The cane hopper, usually called phangi, has caused much injury to sugarcane in the eastern districts during recent seasons. This insect lays its eggs among the roots of the cane, and the eggs lie dormant through the hot weather, the young insects emerge when the rains break, and soon begin to feed on the leaves of the sugarcane

Regarding almost all the insects that come under the foregoing types, it may be said that little or nothing can be done when the pest has appeared in numbers, but that their numbers can be kept down by action taken at the proper time by all or nearly all the cultivators of a locality Much progress has been made in recent years in the study of the life history of these pests, and we now know in many cases the stage of their life at which they are most vulnerable and can suggest changes in agricultural practice which will bring them under control Thus the eggs of the cane hopper can be easily destroyed by ploughing or digging the stubble fields between March and June the borers live through the winter in very small numbers and most of them will be found in the juar stubble, so that if the fields are ploughed and the stubble collected and burnt during the winter there will be relatively few borers in the following rains But it is not easy to convince the mass of the cultivators that the action recommended will be effective A few enterprising men may try it, but this will do no good as there will still be plenty of insects preserved in their neighbours' fields, and the absence of any apparent result will lead to the condemnation of the method In this case, as in so many others, progress depends on the bulk of the cultivators being organised for joint action, probably in the course of the next few years the co operative societies will serve as effective pioneers of the changes

in practice which are indicated as the result of scientific investigation.

White ants.

Three other insects may be mentioned which in their various ways do a good deal of harm, white ants, locusts, and weevils. The familiar white ant *(dimak)* is to be found almost everywhere in the ground, usually it lives on dead matter, but in some places it attacks the seed when placed in the ground and eats off the young root as soon as it forms. The injury is seldom serious in the case of most crops, though the number of wheat plants that mature in a field may be appreciably reduced; but cane suffers greatly if the pieces put in the ground for seed are attacked. The most effective remedy is to dig out the nests, taking care to destroy the queen ant; but timely irrigation will usually prevent serious loss. The use of such manures as caster cake or nim-cake is also advantageous as these are disliked by the ants, and the numbers will be kept down if the land is cleared of stubble after harvest since there will then be little food available.

Locusts.

Locusts appear to breed in very few parts of the provinces but from time to time they pass over us in enormous swarms from their breeding grounds in Rajputana or further west. Where they settle they devour every green leaf and shoot and may cause great loss in a limited area. It is usual to frighten them away by noise when they seem inclined to settle; if they persist the best way of mitigating the loss is to drive them into trenches containing some water. Should they be allowed to breed, the next generation will do enormous damage, so that it becomes necessary to gather by hand the eggs which they have deposited in the ground.

Weevils.

Weevils *(ghun)* are small grubs that attack many kinds of grain when stored, especially during the monsoon, they eat all that is worth keeping and leave only an empty husk Cultivators who store their own grain manage usually, but not invariably, to avoid loss, but grain dealers sometimes lose a great deal in this way Where regular store houses of masonry are not available, the best course seems to be to plaster the inside of the receptacle thickly with cowdung and line it with *bhusa*, further it is advisable to store the grain in several receptacles rather than all in one as weevils spread very fast Small quantities of grain required for seed can be preserved in an ordinary *ghara* with a clay saucer cemented over the mouth, and in all cases it is a recognised rule that grain stores should not be opened during the monsoon The method of storage is however less important than the condition of the grain when stored it should be clean dry, and if possible hot, and the climate in May makes it quite possible to dry the wheat to a degree that will exclude weevils

Fungi.

The third class of pests is the *fungi* A fungus is a group of very small living beings, which cannot (like ordinary plants) draw their food from the air and soil, but require it ready made Some of them have acquired the habit of living inside other plants and feeding on the materials which the plant has prepared for its own consumption, the result being that the plant cannot fill its seeds with food materials, or, in other words, that the out turn of the crop is greatly reduced There are enormous numbers of these fungi, but the only species that do great and common injury in these provinces are those known as *rusts* (in vernacular *ratua* or *girwi*) There are many rusts three are known on wheat, others on barley and others on linseed, their appearances differ in detail, but

they can usually be recognised by yellow, red or dark spots or streaks formed on the leaves or stems They may be observed in almost any field and any season, but as a rule they do not multiply enough to cause serious loss Damp, cloudy weather, however, enables them to spread with enormous rapidity, and where the dampness of the air continues for some time in January and February, very serious damage must be expected.

To take wheat as an example In January small red or yellow spots may be noticed here and there on the leaves of a few plants in a wheat field let damp weather set in and the number of these spots will increase very quickly, so that the whole crop looked at from the ground level has a colour like iron rust, and in places the ground itself is coloured with a rusty powder This means that the fungus is living *inside the plants*, and the rusty powder consists of what are called the *spores* being parts of the fungus (analogous to seeds) which separate off from it and can start a new life When the attack is bad it extends to all parts of the plant, later, long, black streaks will be seen on the stems, while if the ears are examined it will be found that the grain is shrunken or shrivelled, or even in the worst years that there is only a small black speck where the grain should be. In such cases the appearance of the growing crop may be most deceptive, for the damp weather will have made the plants grow high and thick, and an inexperienced observer may think there is an excellent yield if he does not take the trouble to look inside the ears

The study of these rusts is very difficult, and is not yet complete. It is known however that what we have just described in a wheat field is the work of three different species, all living on the plant, and we can say with some confidence that no remedy can be applied. To what extent the attack can be prevented or avoided is a question to which we will return.

Weeds.

Lastly there are weeds It is common knowledge that innumerable plants spring up of themselves on any piece of land that is not hopelessly barren and the cultivator regards any plant in his field as a weed if he does not want it The seeds of plants are present everywhere many are carried about by the wind some by water, some by birds and animals while many lie where they have fallen from the plant Where the cultivator makes a seed bed to start his crop, he cannot help making a seed bed for many of the other seeds that are present, and they germinate along with what was sown Hence follows the necessity of weeding as otherwise the weeds would compete with the crop sown for light and air, for water and plant food, and might smother it altogether These common weeds, however, are not a very serious evil so long as they are taken off the land before they drop their seed, in fact the cultivator uses some of them for vegetables and gives many of them to his cattle, the serious danger is that a plant with a very large root system may establish itself in land and hinder cultivation

A good instance of this is the weed *baisura* which is found in the middle dnab from Aligarh down to Etawah, and also in a few other districts This plant has roots of exceptional depth, so that it can draw water from a low level If it gets a start during the cold weather, it grows almost into a shrub by July and has to be removed by hand, a laborious process, before the land can be tilled again But the best known instance is *kans* grass, one of the plagues of Bundelkhand. Its tough, wiry roots go very deep and also spread sideways, matting together in such a way that a plough cannot be driven through them When then this weed has got hold of a field, the cultivator is almost helpless, and in Bundelkhand he lets the field alone till the weed has worn itself out, a matter of ten to

twenty years The weed can, it is said, be killed by repeated flooding, but water is not to be had where it is commonest, and no other remedy is known at present, though it is probable that effective tillage implements will be devised for its eradication These are the only two weeds that affect seriously large areas of the provinces, though there is no doubt that many others would give great trouble if the fields were not weeded with the minute care they receive

General remarks.

We have indicated above that the seeds of innumerable weeds are present everywhere, waiting for a chance to spring up · a similar remark is true also of fungi and of insects, and this must be realized clearly if we want to see the exact position of the cultivator in regard to these pests. As a matter of fact, the cultivator is not in the same position as a mechanic or other workman. A mechanic takes the materials he needs and makes what he wants out of them, and he need not be afraid that his materials will produce other things of their own accord , a carpenter making a box is not liable to find that his wood and nails have used themselves to produce something quite different But this is very nearly the position of the cultivator His materials are the light and air, water, and the plant food in the soil he may arrange them to the best of his ability to grow a crop of wheat and find that he has got a crop of weeds instead or having got his wheat to grow he may get no benefit of it, because the spores of rust were among his materials and the weather has given them a chance to multiply, and to absorb the plant food which was intended to form the grain

Speaking generally, the plants or insects that we can see living on a square yard of land at any moment are very far from showing its capacities There are probably hundreds of seeds, and thousands of spores lying in the ground,

because the weather conditions do not give them a chance to grow change those conditions by ever so little and some of the seeds or spores may spring into vigorous life and reproduce themselves so rapidly that in a very short time the whole character of the life present in the plot has changed So again all kinds of insects are to be found in small numbers but a change in the weather may start some particular insects multiplying at an enormous rate We do not know in detail all the causes which affect the numbers of these pests but we know in a general way that a very slight divergence from ordinary conditions is sufficient to make an enormous alteration in their numbers When then we hear suddenly as in 1899 of armies of caterpillars marching over the young rice fields and clearing the plants off the ground it is not correct to regard this as something portentous or indicative of divine displeasure the occurrence is unusual of course but it is to be expected in the circumstances In ordinary times these caterpillars like all other living things have to struggle hard for life they have to find their food and to avoid becoming food for other beings Thus out of the enormous numbers that are born very few indeed live long enough to breed But with a slight change in conditions they may get their food much more easily or on the other hand their enemies may be hampered in their pursuit when the enormous speed at which they multiply unchecked gives the idea that they are an entirely new phenomenon As we have said already the cultivator is more or less helpless in the presence of most of these small enemies but at least he knows when to expect them because past experience has taught him that given certain conditions the insects or the fungi appear of themselves

There are however two practical consequences that follow from considerations such as the foregoing In the first place whenever the attempt is made to grow a new

crop in any locality, we must always be prepared to find that the new crop is specially suitable to some insect or another that has hitherto done little harm if so, that insect will multiply with extraordinary speed and may destroy the exotic variety The second consideration is that it may in some cases be possible to avoid the loss caused by a fungus or insect by growing a variety of the crop which (for whatever reason) the fungus or insect cannot live on. An excellent instance of this is found in the history of the sugar cane in these provinces Some years ago a valuable variety of cane, known as *agtul*, was found to be most susceptible to a fungus known as *lawahi*, and by other names For a few years the people suffered great loss from this fungus, which may make a field entirely worthless, then they began to grow other varieties of cane which did not suffer in the same way We do not know, nor does the cultivator know, exactly why some varieties suit the fungus and others do not, but for practical purposes the fact is sufficient Most probably other fungus-diseases and notably wheat rust, will be avoided in the same way by finding varieties that are not liable to the disease, and the search for such varieties is an important function of the agricultural department

Note to Chapter X

A good general view of diseases and pests will be found in Disease in Plants, by Dr Marshall Ward (London Macmillan) The publications of the Agricultural Research Institute at Pusa contain a large mass of information regarding Indian pests and fresh facts are constantly appearing in the 'Agricultural Journal of India" For the relations of birds and insects, the Pusa Memoir named "The Food of Birds' may be consulted

Chapter XI CATTLE AND OTHER FARM ANIMALS

Supply of Cattle.

Practically all the heavy work of the country,—ploughing, raising water from wells, threshing grain and carrying

produce,—is done by cattle buffaloes take some share especially in ploughing wet rice land and in carting, but most important of all is the bullock. In the greater part of the provinces the cultivators do not rear enough bullocks to do all the work of their land, it is of course the ambition of most men to keep a cow for the sake of the milk, and the bull calves born in the village are usually kept till fit for work and then put to the plough but a large proportion of the cattle used are brought from outside There are two great breeding grounds in the provinces Bundelkhand on the south and the submontane districts on the north In both of these tracts the population is scanty and there is a great deal of uncultivated land, the rough grazing on which is sufficient to rear large numbers of young animals When these are ready for work they are brought in droves into the more populous districts and sold either at fairs or from village to village Speaking roughly, the submontane tracts supply most of the cattle imported into Oudh and Rohilkhand while Bundelkhand finds its chief market in the lower duab and parts of Benares The extreme east of the provinces is supplied from Bengal while on the west the rich districts of the upper duab get their large and powerful cattle mainly from the Punjab and parts of the middle duab depend largely on the produce of Central India or Rajputana

Causes of Importation

At first sight it appears unsatisfactory that the country should not provide the cattle it requires but the question is rather complicated If young stock are to grow up strong and healthy they need not only an adequate supply of food but also plenty of space, and speaking generally they are better fitted for hard work if they have had to find their food or most of it for themselves But as we shall see later on the supply of grazing land is limited in the more populous districts, and as a matter of fact, the home reared

animals are usually much inferior to those that are imported, partly because they get only a small share of the milk while young, and insufficient food later on, and partly because the cows also are insufficiently fed during the period when they are giving milk It is always a good thing to give owners of superior good cows a chance of having them served by a really good bull but the supply of bulls for the village cattle cannot be expected to lead to a great improvement in numbers or quality so long as insufficient feeding is the rule

Local Breeds.

As a rule little attention is paid to the choice of a bull for the cows kept in the provinces, they are covered either by a bull taken from work or by one of the sacred animals which are from time to time set free by pious Hindus, and wander over the country feeding at will and choosing their own mates The result is that there are very few recognisable breeds in the populous districts since a breed means the produce of parents chosen for particular characteristics In the breeding tracts on the other hand, endeavours are made to keep the breeds more or less "true to type, a phrase which means that all animals of the breed shall have to a large extent the same characteristics What these characteristics should be depends on what the cattle have to do * a breed may be noted for its size and strength for its quickness of movement, for the quantity and value of the milk given by the cows, and so on In the greater part of the provinces the requirements of the cultivators are chiefly ability to stand hard work on poor food

* Readers whose ideas of what constitutes a "good" breed have been derived from English experience may be warned against applying that experience in India English cattle are bred to produce beef and milk, while Indian cattle are wanted to work, and the qualities required in working cattle are entirely different from those which result in a large production of beef

these characters are possessed to an exceptional degree by some of the breeds in the submontane tracts

While however the cattle in the populous tracts are very mixed, it is possible to distinguish a few main types among the cows Thus in the upper duab the cows are of the western type, approximating to those of the Punjab From the Ganges eastward to near Benares, they approximate to the submontane type, while those of Bundelkhand are allied to the races of Central India A knowledge of these facts is important as a guide to providing bulls where this measure has to be taken In most of Oudh and Rohilkhand a bull from the Punjab is almost thrown away, while a Kheri bull is likely to be useful, and in Bundelkhand neither a Punjab nor a Kheri bull can be expected to do any good.

Cost of Cattle.

With the smaller cultivators cheapness is the paramount consideration as they cannot command the capital required to purchase larger animals In the upper duab Rs 200 is not at all an uncommon price for a pair of plough-cattle, and for this sum the cultivator can get fairly good animals from the Punjab, but in the east of the provinces the price seldom exceeds Rs 75 and falls as low as Rs 30—a sum which will purchase only the poorest type of animal The man who spends a large sum on his cattle is likely to take great care of them to feed and house them well, and to avoid overworking them as far as possible, while the man who can only buy the cheapest animals is usually unable to feed or house them as they require and the necessities of his own existence make overwork a frequent occurrence, hence the wretched condition of so many of the cattle in the districts where holdings are smallest and the people poorest

Prices have risen rapidly in recent years, owing mainly to extension of cultivation on land that was formerly

available for grazing, and there is no reason to think that the rise has reached its limit This change together with other circumstances such as the rise in wages, tends to reduce the stability of agriculture, and to make it necessary for the cultivator to move with the times much more rapidly than in the past

Food

Animals are made up of precisely the same elementary substances as plants though they require to consume these substances in different forms, and convert them into such things as skin bones and muscles not leaves flowers or seed. We have seen in an earlier chapter that the most important products of plants from the nutritive point of view are (1) starch and the various sugars and (2) the proteids, when speaking of animals it is more convenient to call these respectively work food and flesh food The first class supply energy which enables an animal to go on working but the second class (which it will be remembered contain nitrogen) are essential to replace the wear and tear of substance that is constantly going on in an animal body in order to feed an animal so as to get the best work out of it, it is necessary not only to see that the weight of food given is sufficient but also that it contains a due proportion of flesh food Now we have seen that most of the flesh food produced by plants is stored in the seeds and very little of it in the leaves and stems it follows that when cattle are doing hard work they ought to receive a fair amount of seed or grain as well as fodder and even when they are idle some grain should be given to keep them in really good health In the west where the cattle are expensive, this is recognised by the cultivators, and the cattle, which are kept tied in the cattle house when they are not working or at exercise, get a ration of gram or some other cheap food grain, or of cotton seed or of oilcake, which consists of the seed after most of the oil has been removed. But further

east where holdings are small and the cattle poor, the cultivator—who must feed his family first—can at most give his cattle a small supply of grain when their work is hardest, usually when raising water from wells, and the rest of their time they have to do as best they can on the dry fodder he is able to give them supplemented by what they can pick up when turned out to graze

The bulk of the food of cattle comes from the parts of plants which are not required for human consumption from November till April it is the chopped stems of juar and bajra, or the trodden plants of the autumn pulses while from May to October it is the trodden plants of the rabi crops But in almost all cases this supply has to be supplemented in one way or another In the west crops are grown especially for fodder, which is cut while green and given to cattle in the east the cattle have to look for some part of their food on the waste and barren land that is included in the village During the rains and the early cold weather, all but the very worst barren land bears a crop of grass which, though not very nutritive, suffices to keep the cattle in tolerable health, but in the season from January to June the ground has been eaten bare and there is nothing on it except a few scattered tufts of grass or other plants which have to be searched for over a wide area and at this season the condition of the cattle is generally inferior, and may be miserable in the extreme Whether more use can be made of the waste and barren lands as grazing grounds is a question that has been studied for many years, but so far with no results of practical value

Fodder famines.

It will be readily understood that as so much of the food of the cattle is dependent on the staple crops, any failure of these must have a disastrous effect On the whole, a fodder famine is the worst calamity that can befall

the people it does no necessarily come whenever there is a food famine because it may happen as in 1896 that the kharif crops grow large enough to give a supply of fodder though yielding little or no grain but it seems to be inevitable over large areas when juar and bajra have made little or no growth. The emergency cannot be met by the individual cultivator to any great extent some men will send off their cattle to graze in the lowland or in the forests if not too far off some will make hift to raise fodder crops on their irrigated land though in most cases this has to be devoted first of all to producing food for the family but the majority are helpless and large numbers of cattle must die either from sheer starvation or from illness brought on by inadequate or unsuitable food. Then it may happen that when rain comes and the land can be ploughed there are not enough cattle to do the work. The organisation of the fodder supply in such emergencies is a problem that has to be faced by Government but it does not seem likely that the problem will ever be completely solved and at the end of a famine there will always be the need for supplying the cost of new cattle to cultivators who would otherwise be unable to plough their land this is of course primarily the duty of the landholder whose direct interest requires that his land should not lie fallow but his efforts have as a rule to be supplemented by Government as well as by charitable funds which indeed can be expended in no more profitable manner

The experience of serious fodder famines in these provinces is fortunately scanty. During the scarcities of 1906 and 1908 arrangements were worked out to cut very large quantities of grass in the submontane forests and in Bundelkhand and to offer it as an advance in the districts where the need was greatest and probably these operations will be undertaken on the same general lines when the emergency recurs

Water.

Cattle need considerable quantities of water, and the most satisfactory way of supplying them is from a tank dug near the village and kept full from the canal, the cattle can be driven to the tank and can drink as much as they want Where, however, the village is not served by a canal, the tanks are apt to be dry for a large part of the year or to contain only a little impure water where this is the case water must be drawn from the wells Nearly all parts of the provinces have sufficient wells for the supply of drinking water for the cattle as well as for the people *so that so far as can be judged from past experience* there is no danger of a general water famine, but in parts of Bundelkhand the supply is barely sufficient in ordinary years and fails altogether in drought

Shelter

Cattle also need shelter from the heat and cold The expensive cattle get this being usually housed in mud walled enclosures with thatch roofs and occasionally in the western districts getting some litter (usually sugarcane leaves) on which to lie during the coldest part of the year, but as we go east the use of litter becomes unknown, the enclosures become rarer and the cattle are often tied in an *open space and sometimes without even a roof* The loss resulting from this practice is at least threefold to begin with the extremes of temperature affect the animals' general health very much as they might affect a man, and they are not in a position to work their best secondly, there is an actual waste of food and thirdly there is a loss of manure We have already discussed the manure question but the loss of food may be noticed briefly What we have called work food is used up in the body partly in maintaining it at a constant heat, we know by experience that the temperature of the human body remains constant whether

the air is hot or cold any divergence from the ordinary temperature being a sign of sickness which the doctor looks for with his thermometer, and we know from our own experience that we want more food in winter than in summer The reason of this is that more food is used up in keeping the body warm, from this point of view the food is like fuel which is burnt to produce heat There is no difference in this respect between man and animals, and the colder an animal is the greater the quantity of food that it uses up in maintaining its temperature and consequently the less remains to enable it to do work Exposure to a cold wind means that an animal s skin is being constantly cooled on the outside and being constantly supplied with more heat from within so that it is a waste of food to expose an animal unnecessarily

Exercise

In order then to keep working cattle healthy, the points to be attended to are to give them a sufficient supply of water and of nourishing food and to shelter them when at rest Further, they should have regular exercise, and when they are not required for work they should be sent out to graze and overwork must be avoided wherever possible If these conditions can be secured the best value will be obtained from the cattle provided they escape from epidemic disease

Disease

There are four common kinds of epidemics known respectively as rinderpest anthrax foot and mouth disease and haemorrhagic septicaemia Their symptoms can best be learnt from the publications of the Civil Veterinary Department The people know them well by experience but the vernacular names used are very numerous and confusing Anthrax is generally fatal but it is rarer than the others rinderpest is the worst of the four as it is very

common spreads rapidly and kills a large proportion of the cattle affected, while with foot and mouth disease the number of losses in the provinces is small, but the disease weakens the cattle for a time if not permanently. Haemorrhagic septicaemia is also very fatal, and may spread rapidly

In all three diseases, medical treatment is of comparatively little use, careful nursing may of course save an animal here and there but as a rule, the disease runs its course and the great aim of the cattle-owner is to prevent his animals being exposed to infection Until the last few years the only way of protecting them was to isolate them entirely from all other cattle immediately the disease was known to be in the neighbourhood it was necessary to keep them tied up at home and supply them with fodder and water, for if they were to go out to graze, or to the tank to get water, there was every danger of infection, and even a chance encounter with other cattle in a street might have fatal results Such precautions were and still are of the greatest value but they cannot ensure absolute protection, even a man who takes every precaution in a cholera epidemic cannot be certain of escaping the disease and with cattle the causes of infection are less certainly known and the risks are correspondingly greater Further, a poor man who ties his cattle on the roadside, and has no fodder in store cannot segregate them effectively, while cases have been known where the village leather workers (who are by custom entitled to the hides of animals dying in the village) have introduced rinderpest into the stalls of large cattle owners in order to increase the amount of their perquisites The existence of this dastardly practice would be incredible if we did not know that in some localities cattle are frequently poisoned by the same classes and with the same object Landholders can easily protect their village against the disease being intentionally spread if they insist that the

carcases of all animals dying of infectious disease shall be burnt and no part of them given to the village animals if wood for burning is not available dried dung can be substituted a layer being placed under the carcase and more piled up round it

Protective inoculation

Systems of protective inoculation have been devised for both rinderpest and haemorrhagic septicaemia which now make it possible for an owner of cattle to ensure himself with a high degree of certainty against loss. A small quantity of a watery fluid is injected in the animal to be protected and the effect lasts for a considerable time certainly for long enough to allow the epidemic to wear out The cattle need not be isolated after the treatment indeed it is recommended that they should be allowed to run free for if by doing so they get the disease they get it in a very mild form which may protect them against another attack at a later period. The prospects in these provinces of this system of inoculation the first fruits of applying the highest scientific knowledge to the agriculture of the country were at first doubtful because the people were prejudiced against the idea but its success has gradually secured public favour and at the present time it is welcomed in most districts There is now a reasonable probability that outbreaks of these diseases can be prevented from spreading provided that information reaches the inoculating staff at once and landholders can do much to protect their estates by sending information at once and by seeing that the inoculator's time is not wasted on the journey or in the village

Dairy produce

We may now notice briefly the dairy products obtained by the people of these provinces. We have seen that when a plant forms seeds it provides for the new plant a store of food sufficient to nourish it till it is able to maintain an

independent existence In exactly the same manner animals provide for the nourishment of their young in some cases as with birds the nourishment is stored up along with the embryo, so that an egg is directly analogous to a seed, but with animals, such as cattle, the provision is not supplied all at once but is offered as required in the form of milk Now as milk is produced with the object of feeding the calf, it naturally contains the same sort of things as are *found in seeds*, *there is a form of sugar (which a young* animal can digest more easily than starch), there is fat and there are proteids And just as man appropriates the store of food in seeds, so he takes the milk for his own uses, leaving only a small share for the calf and training it to find food for itself earlier than it would otherwise do Milk then is an exceedingly valuable food, particularly for children, and as we have said almost every family is ambitious of possessing a cow Not only is the milk consumed in its original form but the different substances which it contains are extracted for separate consumption Thus in Europe the fat is extracted in the form of butter and the proteids in the form of cheese in India different processes are followed and the final products differ accordingly Butter is little used owing to the great difficulty of keeping it without deterioration, so that immediately after extraction it is heated and clarified and the resulting product is known as *ghi*,* *which is used universally by the better* classes for cooking purposes and which is exported in considerable quantities to the cities of Bombay and Calcutta The proteids are usually extracted in the form of curds milk is readily attacked by a large number of bacteria which produce various kinds of fermentations

* Butter is readily attacked by certain bacteria and converted into an evil smelling substance this danger is averted in the case of *ghi* by the repeated heating which is part of the process of manufacture, as the heat destroys any bacteria that may be present.

leading to different results and as the result of one of these fermentations the proteids separate out in a more or less solid mass known as *dahi* or curds and greatly relished by the people

The amount of milk and also the proportion of nutritive substances which it contains depends partly on the breed or individual and partly on the feeding There are great differences between individual cows of the same breed and the cows of one breed differ widely from each other there is no well known milking breed in these provinces and the better classes get their cows from the west where this character has been developed but the poorer cultivators have to content themselves with an ordinary cow of the locality which gives a small quantity of very poor milk But the best cow will give poor milk if she be not properly fed the large quantities of food materials found in the milk can be derived only from the food which the cow has received and in particular as the milk is very rich in proteids the cow requires a large supply of flesh food that is to say either grain or oil cake Thus with cows as with working cattle good food is necessary if they are to give the best return to their owner

It is worth knowing that the ordinary buffalo gives more milk than the cow and it is much richer in butter fat The best milkers that can be got in these provinces are the enormous Hissar buffaloes imported from the Punjab

Sheep

The other animals with which we are concerned require only a brief notice Sheep are kept partly for their meat and partly for their wool unless specially fed up for the butcher they do not get any food except what they can pick up when feeding on the roadsides or waste land or gleaning in the fields after harvest They eat such small plants that they can find food where cattle would starve and as their dung and urine are both of great value as manure,

they are often kept on fields after harvest where they eat the weeds and stubble, and incidentally enrich the soil by their droppings Their wool is worked up into blankets and other coarse native stuff, it is of the very poorest quality, as might be inferred from the way in which they are fed and from the warmth of the climate For good classes of wool it is necessary to go to the high hills, where the grazing is richer and the climate colder, so that the sheep are in a position to grow good wool and at the same time require it as a protection

Goats.

Goats are valuable partly for their meat, which is relished by Muhammadans, and partly for their milk they are in fact the poor man's cow They can pick up a living off almost any sort of vegetation, but they appear to prefer the younger shoots and leaves of trees, and for this reason they are the greatest enemy of the tree-planter, but they are useful animals to their owners as they turn all kinds of waste vegetable matter into food for human beings

Pigs.

Pigs are kept only by a few of the lowest castes and are generally regarded as a pollution, they feed on all the refuse about the village as well as on roots and anything they can get hold of and they leave behind them nearly as much dirt as they consume High caste cultivators are often anxious to have the pigs kept out of the village by the authority of the law they have the remedy in their own hands, for the pigs come among the houses to search for food, and if the site is kept clean as it should be, the pigs will go elsewhere There is a regular market for pig's bristles, which are used in brush making, while their flesh is relished by their owners

Poultry.

Poultry too are unclean to nearly all Hindus, and are kept only by a few low classes of that religion, but more generally by Muhammadans they have as a rule to find their own food, and their produce, both meat and eggs, is of the most wretched type Really good poultry can be reared in this country, as may be seen where Europeans have taken the matter in hand, and a gradual improvement in the quality may probably be expected.

NOTE —The best account of the cattle of the provinces will be found in *Breeds of Indian Cattle Notes on the Indigenous Cattle of the United Provinces* published by the Civil Veterinary department Some of the bulletins issued by the Agricultural department also deal with cattle

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CHAPTER XII —MANAGEMENT OF A HOLDING

Custom of the country.

We have now to enquire the principles on which an ordinary cultivator manages his holding His objects are first to secure enough food for his family and his cattle, secondly, to have enough produce to sell to pay his rent and other cash expenses of the household, and if possible to put something by, and to grow for himself such necessaries other than food and such comforts and luxuries as his holding can yield, he must also endeavour to manage his holding in such a way that the productiveness of the land is not diminished Now considering the variety of soils and of possible crops, this looks like a very complicated problem, and it is fortunate that the individual cultivator has not to face it without some guidance The question has been attacked by many generations of cultivators and their accumulated experience is to be found in the *custom of the country* which guides the individual on such questions as what crops can be safely grown on hot soils, what crops will repay irrigation, what is the best means of distributing

manure over the holding, in what order should crops be grown, and so on This custom of the country is not an infallible guide to the most profitable utilisation of the holding the best course may never have been tried or may have been discarded through some mischance or changes in the level of prices or in the demand for particular products may make some changes in the custom desirable, but it is usually a safe guide to making a living and the ordinary cultivator is well advised in following it rather than applying his limited intellect to working out a solution afresh It is true that this adherence to custom may delay the introduction of desirable improvements but it must also be remembered that the cultivator cannot afford to risk much in experiment and among the better cultivators there are usually to be found men who will depart from custom where they see a reasonable prospect of success It follows that the student of agriculture in its local aspects must first know the custom of the country and then consider in the light of the principles he has learnt whether that custom is capable of improvement

Management of a typical holding

To see how this custom works out in practice we may take the case of a holding of the ordinary size say five or six acres containing different soils There may be a field of high sandy land it cannot be irrigated and it dries so quickly that it would be very risky to sow rabi on it this land will usually have a kharif crop But even in the kharif it is not very productive for it will suffer from either wet or drought not very much will be spent on its tillage and it will usually be sown with cheap crops such as bajra and moth which do fairly well on such land at a small expenditure There may be another field of heavy clay this will be regularly sown in the kharif with rice the only crop for which it is really fitted while if possible some cheap pulse will be sown with rough tillage after the

rice has been gathered. The rest of the holding consists we will suppose of irrigable loam. One portion of it however is so lowlying that it is always more or less flooded in the kharif this portion will probably be sown regularly with a rabi crop which may sometimes be wheat and sometimes a mixture of wheat or barley with gram or peas The rest of the land is suitable for either season and will be divided between the two in such a way that tillage can be effected in the time available It will not be all under kharif because there would not be time for tillage nor will it be all under rabi partly for the same reason and partly because the cultivator wants to replenish his food stock as soon as possible in the year Possibly he will do this in the following way taking the field nearest his house he will apply his manure to it and sow maize which will be followed by some rabi crop another field he will put under juar, arhar and urd with some til to supply his house with oil and a border of hemp to give fibre for well ropes & the remaining land will be left for the rabi and (after manuring) sown with wheat along with a border of linseed or some lines of rape seed (to supply more oil) In this way the cultivator would get an early supply of food from his maize say about the end of August or September rice in September or October juar bajra urd and moth in November arhar and whatever cheap rabi crops he had sown in March and April when he would also have his wheat ready to sell for the rent he has probably sold some of his rice or maize to pay part of the rent falling due in November or December

This is the holding of a cultivator of no special skill a better man would get in a field of sugarcane or opium or would manage to save more manure and take two crops in a year off a larger area but the general principles will be the same to secure sufficient food with preferably an

early supply in the kharif, to have something to sell, to have a good variety of crops, and to arrange so that there may be time to till for all with the single pair of cattle which is all that a holding of this size can support

Mixed crops

We must now consider the reasons for mixing several crops together perhaps the most typical feature of duab agriculture To begin with mixing is a sort of insurance against vicissitudes of weather especially in the kharif Thus large areas in Oudh are sown with rice and the small millet known as kodon if the season is wet, the rice flourishes if dry the kodon so that in either case the cultivator has a reasonable prospect of getting something A similar case is the mixture of coarse rice with juar rare on high land but frequent in some river valleys In this case if the river comes down in flood the juar is spoilt but the rice good if there are no floods the rice is poor but the juar magnificent A second reason is to economise tillage thus it costs no more (apart from the seeds) to sow juar and arhar than to sow juar alone but two crops are obtained instead of one the juar grows more quickly and the arhar plants grow slowly in its shade but when the juar is removed the arhar rapidly develops and yields perhaps two thirds of what it would have given if there had been no juar The element of insurance also enters into this case if the juar is very luxuriant the arhar will be stunted in its early growth while if the juar is poor the arhar will develop much better Another object is to occupy the whole ground and thus check waste of water by evaporation from the soil if you look at a well grown juar arhar field you will see that the ground is by no means fully shaded from the sun and that the rain has beaten its surface more or less firm here there is a good deal of waste of water by evaporation from the soil This is prevented by sowing

some creeping pulse such as urd along with the juar, the urd forms a dense mat on the ground and makes use of the water that would otherwise be wasted to provide a certain amount of food The mixture of bajra and moth already mentioned has the same advantages Yet another reason is to be found in the different habits of the roots of different plants some plants are deep rooted and draw most of their food from some way below the surface, while others have spreading roots which feed close to the sur face By mixing two crops which feed at different depths both can thrive without interfering with each other, and the total produce of the land will be increased. This is particularly the case with a mixture of juar and arhar as the roots of the latter crop are much deeper than those of the former Another advantage is that by the use of these mixtures it is possible to keep up the supply of combined nitrogen in a way that would be inconvenient on small holdings if crops were not mixed The common crops which afford homes for the bacteria which produce combined nitrogen are in the kharif, arhar, urd mung moth indigo, hemp, and in the rabi gram peas masur Now the people do not care for a diet of unmixed pulses, and there are physiological reasons for their objections, but if in order to maintain the supply of combined nitro gen it were necessary to devote whole fields exclusively to pulses difficulty would arise on small holdings in maintaining a suitable variety in the food of the people This difficulty is obviated by the mixing of crops The most striking feature of this system is that (with one or two exceptions) at least one plant in each mixture is of the pulse type that is it increases the supply of combined nitrogen. Thus arhar urd &c are grown largely with juar bajra and cotton gram and peas are mixed with barley gram is mixed with wheat, and so on in all these cases the common feature is that a suitable variety of

produce is obtained while the land is benefited by pulse

Rotation of crops.

In enumerating the *reasons* for growing mixed crops, it is not meant that the individual cultivator recognises these reasons as such the method has been developed gradually as the result of experience, and the reasons we have given go to show that experience is not misleading and to explain its results Similar considerations apply to the practice which has grown up under which a definite order of cropping is followed on a particular bit of land this part of agriculture is known as *rotation of crops* Rotations such as are found in England, providing in advance for the particular crops to be grown in each season for a series of years have not been established in the United Provinces the existing conditions require a greater degree of flexibility to meet accidents of season and changes in the market but the general principles of rotation are well understood The common rotation is most easily recognised in the medium lands suitable for either kharif or rabi In the case of these lands the rules followed over the greater part of the provinces are (*a*) a field should bear a kharif crop in one year and a rabi crop in the next, (*b*) either the kharif or the rabi crop should be wholly or partially pulse so that a crop of pulse is grown at least once in two years Thus a field may in the first year bear juar arhar urd, and in the second year wheat in the third year it will again bear a kharif crop which may be as before juar, arhar urd, or some variant such as cotton arhar or perhaps juar alone in the last case it would not be considered proper in ordinary cases to grow wheat in the fourth year wheat gram or gram barley would be preferred

This simple rotation is of course subject to alteration owing to many causes · we may enumerate the following

disturbing factors (1) manuring (2) special features of soil (3) locality, (4) special needs of the cultivator In the heavily manured home lands (gauhan or goind) the normal rotation may be altogether neglected, as the supply of plant food is maintained by manuring perhaps the strongest case of this is a tract near Farrukhabad where each field gives every year three crops (maize, potatoes and tobacco) each requiring much combined nitrogen and none contributing to the supply this is rendered possible by the use of large quantities of poudrette every year Ordinary gauhan land does not get enough manure to stand such treatment but at the same time it can usually give two crops a year Another case where manuring affects the rotation is sugarcane as cultivated in Oudh this crop is heavily manured and does not use up all the manure applied consequently a crop of wheat is very generally taken the year after the cane has been cut, and thrives on the manure left over in the soil After the wheat however a kharif pulse mixture usually follows

To illustrate the effect of special features of soil we may take the rice lands where rice is grown every kharif In such cases it is usual to grow gram or peas in the rabi when the land is fit for sowing so that most rice land on the average bears a crop of pulse at least once in three years The yield of pulse is small but it costs little beyond the seed and the cultivators hold(what is certainly true) that the pulse benefits the succeeding rice crop

Another case of the same kind is to be found in the unirrigated sandy lands which as has been said above are only fit for a poor kharif In this case the same crop is sown year after year but it is important to notice that that crop is usually a pulse mixture so that the treatment of the land is as good as possible under the circumstances

The influence of locality is seen in the case (given above) of land being so subject to flooding that only rabi

can safely be grown on it In this case again pulse or a pulse mixture is frequently grown so that if wheat is sown in one year, the next year's crop will usually be gram or gram barley

Finally there are the special needs of the cultivator after a bad year his supply of food may be so short that he breaks the rotation in order to replenish his stock at the earliest possible moment In this way after a famine large areas are sown with maize and the early millets which would in ordinary years be left till the rabi, and the same cause is at work though less obviously in individual cases during most seasons

The main advantages of rotation—the maintenance of the supply of plant food—will be apparent from what has already been said incidentally it may be mentioned that alternation of deep-rooted and shallow rooted crops is most desirable in rotation just as it is in mixing crops In another aspect rotation is of great importance in controlling insect pests and fungoid diseases As we have seen in a previous chapter many of these are carried over from season to season in the field where the crop has been grown or in its immediate vicinity and if the same crop is sown in the following year the pest or disease finds favourable conditions for spreading while if a different crop is sown the conditions are adverse

Double-cropping.

It is probably necessity that leads to the extended double-cropping (i e taking two crops in the year) off unmanured land a practice which has often come in for wholesale condemnation So far as our present knowledge goes double-cropping certainly pays with high cultivation but it is doubtful whether in the long run it may not result in some deterioration of the land, its worst feature is the imperfect tillage which as a rule is all that is possible before sowing the second crop

Fallowing.

A cultivator does not willingly leave ordinary land fallow for successive seasons, for the simple reason that his holding is too small for such a course to be adopted it is therefore unnecessary to consider whether or not a regular system of fallowing would be an improvement or the reverse, but at the same time it must be noted that most fields get periods of rest from time to time Thus in the standard rotation of rabi and kharif alternately, the rabi is followed by nearly three months rest, and the kharif by nine or ten months (except where it includes a stand over crop such as arhar) These lengthy periods of rest are most important as giving time for fresh supplies of mineral plant food to become available, and for the bacteria in the soil to develop Both processes will be materially advanced if the land is tilled early in the period, hence the importance attached by the people to a January ploughing for the kharif and to preparing land for the rabi as soon as possible after the kharif crops have been sown We have discussed in a previous chapter the difficulties in the way of keeping the fallows under tillage, and the methods by which it is hoped to effect some improvement in this direction

In some countries an objection commonly urged against leaving land fallow is that the nitrates are washed out of the bare soil but there is little danger of this happening in these provinces in most of the cases mentioned above, as little rain falls during the fallow period and in any case though nitrates may be lost the conditions for their formation are greatly improved In the case of sugarcane, where a full year's fallow used to be given, it is becoming usual to take a quick growing crop off the land in the rainy season instead of leaving it bare, sann hemp is a favourite for this purpose as it has the great advantage of growing so close that it smothers the weeds, while—

being one of the plants that harbour the nitrogen bacteria —it probably leaves the soil at any rate no poorer than when it was sown

More extended fallows are due usually to some accident of season which prevents the land being sown thus in a year of famine many fields may bear no crop at all It is commonly believed that such land is particularly fertile when it is again brought under cultivation, but we need hardly discuss the question, as such cases are exceptional Apart from them the land gets as much rest as the cultivator can afford to give it

Management of labour.

The management of labour on a holding is at first sight a complex problem To begin with, the amount of labour that is needed varies from month to month In July sowing and then weeding take all available hands in August there is less to do, and the cultivator is usually able to start ploughing for the rabi, which is also his principal work in September October and early November is again a very busy time as part of the kharif harvest and the rabi sowings have to be fitted in The sowing over, November and December can be given to winding up the kharif harvest, then the irrigation of the rabi keeps the village busy till February, and the rabi harvest begins in March May and June are the slackest months, when the cultivator repairs his house and does any odd jobs that have been left over from the busy season Where sugarcane is grown, the harvesting and manufacture of one crop and the sowing of the next fill up the time from January to March, and the necessary irrigation adds greatly to the work to be done in the hot weather

The ordinary cultivator does not keep his labourers on a monthly wage he gets as much done as possible by his family, and he may perhaps employ a ploughman regularly, but at busy times he hires his labourers by the day,

paying them either in cash or by a recognised weight of some food grain Further, there is a very general system of co-operation by which cultivators exchange their labour. Every man does not want his work done just at the same time as his neighbour, and so four or five cultivators may labour in the fields of each in turn doing such work as cutting sugarcane or raising water for irrigation This co operative system is of great advantage each individual is employed when he might have nothing to do on his own holding, while he gets his work done quickly and without payment at the time when it is urgent, in fact the cultivator works for the time as a labourer but instead of getting wages in the ordinary sense he gets others to work for him in return and does not need to keep so much capital in hand for paying wages

The extent to which a cultivator can depend on the labour of his family is a very important element in the economy of the farm Among the lower castes of agriculturists every one works thus the cultivator may be seen distributing water over his field while his son is driving the bullocks at the well, his wife empties the bucket as it comes up, and two or three small children are helping their father and patching up the water-courses wherever they let the water escape This unpaid labour is especially valuable because all alike are interested in the success of the crop, and are stimulated to work their hardest while the hired labourer here as elsewhere wants to get through the day as easily as possible With the higher castes it is different the women frequently do not appear in public, and so cannot work outside the house and labourers have to be hired to take their place In some clans again the men hold certain kinds of labour to be "bad form" thus some Oudh Thakurs will not plough, but must pay a ploughman to do their work for them Such customs increase the cost of the holding very greatly, or rather

this would be the case if the holding were to get all the labour it requires, but in practice the high caste cultivator usually stints his land and gets a poorer return from it, so that the holdings of these classes can often be picked out with certainty in a rapid walk through a village

The last decade has seen a distinct rise in the wages that have to be paid for agricultural labour, and this change is reacting to a certain extent on the social customs mentioned above Speaking generally, the higher castes are probably doing more work than was formerly the case, and if at the present time they are frequently unskilful, it may be that habits of industry will gradually be formed which will be of permanent productive value

It should always be remembered that the system of cropping and the labour supply in the village fit in with each other A village which is usually half kharif and half rabi could not be sown entirely with kharif, because the necessary labour would not be available, and if it could be sown the labourers would be starving in the spring because there would be no work connected with the rabi So again a wet cold weather may be very hard on the labouring classes because there is no irrigation to be done, and irrigation is the principal employment in January and February

Management of cattle.

The system of cropping, however, does not depend wholly on the labour supply the cattle have also to be considered A pair of bullocks cannot plough more than a certain area in a day, and the amount of land which a cultivator can sow with a particular crop is strictly limited by the work that can be done by his cattle, supplemented by any aid he can borrow from his neighbours The amount of work that can be done by cattle depends on their strength, which can be very fairly measured by the price that is paid for them, and it is noticeable that the

price declines from west to east In the Meerut division many cultivators can pay prices sufficiently high to secure excellent animals that can pull a heavy plough and till the land thoroughly, they can therefore do with comparatively few ploughings and can manage a large area, perhaps eight to ten acres with a single pair In Oudh on the other hand lower prices must be paid, and the plough is suited to the weaker animals, one ploughing with it is much less effective than one with the Meerut plough, but the number of ploughings is greatly increased, often doubled, so that ultimately the tillage in the two cases is about equal But the Oudh cultivator can manage only from four to six acres with his single pair, or little more than half the holding of the Meerut division. And what is true of tillage is equally true of irrigation, the strong cattle work a large well bucket and in a day may raise nearly twice the quantity of water that the weak cattle can bring up with a small bucket so that they can keep the larger holding fully irrigated Thus is a general rule, strong cattle are found where the holdings are large and weak cattle where they are small It must not, however, be inferred that the small holdings are due to the weak cattle or *vice versa*, they are alike factors in the existing system Thus the Meerut cultivator can get a fair-sized holding, and it pays him to have good cattle and gear cut down his holding by one-half and the result might be different The important thing to remember is that at any given time a system of agriculture exists in each locality which is composed of the size of the holdings, the class of crops, the supply of labour, the size of the cattle and various other factors We cannot suddenly change any single factor without upsetting the system. If, for instance we give a first class pair of bullocks to a man living on three acres, he will find it impossible to feed them off his holding if the rate of

wages rises suddenly, the class of crops grown will deteriorate if a given crop becomes unprofitable the labour market may be disorganised. The system, like others, will accommodate itself to gradual changes it is conceivable (*though not I think likely*) that with an increase of population the Meerut holding may be reduced to the size of those that now exist in Oudh, or, to take a more improbable case that the population of south Oudh may take to an industrial life and that the size of the holdings may increase greatly but these changes would come about gradually and probably would not attract notice till they were far advanced Sudden changes of the kind are almost inconceivable

We have insisted at some length on the importance of this point — the inter-dependence of the parts of existing systems —because it explains so many things that strike us when we first look at a particular village We may condemn practices here and suggest improvements there but *before expressing our judgements it is wise to consider* how they square with the system as a whole, and whether the cultivator can reap the benefit we suggest without losing something that is at least equally valuable

We may then conclude this chapter by repeating that to the ordinary cultivator the management of a holding is a much simpler problem than it looks when we consider it for the first time He knows what his cattle can do, what labour he can get what classes of crops he can grow, and he cannot afford to do much in the way of experiment *His merit and his profit alike lie in* making the most of what he has got Hard work for himself, fair work and good food for his cattle economy in his labour bill, sedulous care for his manure heap, and the acquisition of a thorough knowledge of every part of his holding,— these constitute his more or less conscious ideal, and his

success depends on the extent to which that ideal is realised

Note to Chapter XII

It is to be regretted that we have very few trustworthy accounts of the management of individual small holdings The best account is to be found in the late Mr F N Wright's *Memorandum on the Agriculture of the Cawnpore district*, a work which is still to be found in many libraries in the provinces

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CHAPTER XIII—MANAGEMENT AND IMPROVEMENT OF ESTATES

Introductory.

Hitherto we have been concerned mainly with the cultivator, that is with the man who actually sows and reaps the crops, whatever may be the nature of his right to occupy the land In many villages in the provinces the cultivator and the landholder is the same person but it is more usual for them to be distinct and the object of the present chapter is to indicate the principles on which a landholder should deal with his cultivating tenants

In the first place, he is not free to deal with them as he likes the law in Agra differs in many respects from that of Oudh, but they agree in imposing various limitations on the landholder both in the amount of rent he may charge the measures he may take to collect it and the circumstances in which he may get rid of a tenant. All that we have to say in this chapter assumes that the landholder does his best to act in accordance with the law, so far as he understands its provisions

The landholder's object.

Now just as the cultivator tries to get the most out of his land so the object of the landholder is to realize as large an income as he can The cultivator however knows that he must manage his land so that its productive powers shall not be seriously diminished and in the same

way the landholder ought to realize though he does not always do so, that it is his direct interest that his tenants shall be prosperous, that is to say, that they shall be in a position to make the most out of the land they occupy In a word, the interest of the landholder is that his land shall be as productive as possible and the share of the produce which he takes from the tenants must be so calculated that it shall not in any way affect their efficiency The recognised maxims of the best landholders follow directly from this central principle

Maxims of management.

The leading maxims may be summarised as follows The rent should be fixed for a fair term of years it should be considerably below the highest rent which a tenant could possibly pay it should be collected strictly in ordinary years, but leniently in years of bad produce, a tenant who pays fairly well should be kept on the land and when land is vacant, great care should be taken in selecting a tenant for it If these maxims are followed, the landholder may be fairly sure that his property will not deteriorate permanently in value when we have explained them in more detail we will pass on to consider how its value may be actually increased

Fixed rents

The maxim that rent should be fixed for a term of years is in most cases embodied in the law, but it is a custom of old standing to make extra demands on the tenants in addition to the rent Very often a landholder can in this way secure a little immediate gain, but it is at his own expense if the future is considered, if he does not take from his tenants in all more than they can afford to pay, it is directly in his interest that the whole should be classed as rent since the courts fix rents with reference to the standard prevailing in the locality and it is for the

landholder's advantage to keep this standard as high (within due limits) as possible And if in all he takes more from his tenants than they can afford to pay he contravenes the second of the maxims we have stated. Further if the extra demand varies from year to year with the landholder's caprice it is likely to fall most heavily on those tenants who are doing best and thus directly to discourage the efforts of the most skilful cultivators that means a reduction in the produce of the estate and that involves ultimate loss to the landholder Again the landholder's servants are more likely to act fraudulently in connection with these extra items than with the rent which is known definitely and has to be accounted for

Amount of rent

Next as to the amount of the rent that should be fixed When a tenant is in occupation of a holding and competition for land is keen it is sometimes possible for the landholder to take from him the entire produce of the holding except an amount which is barely sufficient to keep his family and his cattle alive and this policy is deliberately adopted by a few landholders Here too an immediate gain in income is dearly purchased in the long run. A tenant who knows that the fruit of every effort on his part will be taken by the landholder has lost the greatest incentive to making the most of his land at the same time his own labour and that of his cattle loses in efficiency for want of an adequate supply of nourishing food when his starved cattle die he cannot replace them by any but the poorest and cheapest kind he must go on using worn out implements for want of money to purchase new ones in short all causes combine to make the produce of his holding fall far short of its capacity And when bad seasons come he can often pay no rent at all, he has nothing laid away, and his badly tilled land suffers far more than a properly managed holding under the same

calamity As a matter of fact, many landholders whose rents are screwed up to the highest point do not get a higher income over a series of years than those whose management is more enlightened they may get more in a good year, but they lose very much more in bad seasons When a cultivator knows that a substantial portion of any increased produce he may raise will belong to himself he has every incentive to make the most of his land and of his own labour he can afford reasonably good cattle, and can keep them in better condition, and he is in a far better position to meet adverse seasons

We have put the case for moderate rents on the ground that they pay the landholder best in the long run but it is needless to say that the principles of religion and morality point in the same direction, and also that the happiness of the landholder himself depends to a large extent on the relations that subsist between him and his tenantry

Collection of rent

When then a landholder has fixed moderate rents, he need have no hesitation in collecting them firmly in ordinary years The tenants can pay and are with surprisingly few exceptions ready and willing to do so except when they have been demoralised by bad management in the past, and it is undoubtedly best to get rid of a regular defaulter without unnecessary delay But when a bad season comes, and still more when a series of bad seasons is in progress, it is the landholder's interest as well as his duty to collect his rents with discrimination and with regard to the circumstances of each individual When the rains have failed and all food is at famine prices, no consideration is needed for the cultivator who has been able to sow a large area of irrigated wheat and to secure a good crop for the high price he realizes makes him able to pay his full rent without difficulty, but his neighbour

who has been able to get very little water may not have more than enough produce to feed his family and may throw up the struggle in despair unless he draws fresh hope from a prompt remission of part of his rent or the grant of easy terms for repaying the accumulated arrears The landholder's great object in such seasons should be to keep the tenants hopeful and inclined to make the best of every chance that turns up despair is the greatest danger

Choice of new tenants

Finally it is obvious that when land is vacant the utmost pains should be taken in selecting a cultivator for it One man may not perhaps offer more rent than another but a prudent and skilful cultivator is far more likely to pay the rent regularly and (the fact is so important that it bears repetition) the landholder's advantage lies in a moderate rent roll which he can count on collecting and not in a rent roll so high that the amount collected in any year can never be estimated beforehand

Qualifications of landholders and agents

It is obvious that a landholder who attempts to comply with these maxims must know a great deal about the capacity of his land and the capacities of his tenants" It is true that the larger landholders cannot know all the details of the numerous holdings on their estates but they can select the right type of agent and they can know enough to make sure that the agents they have selected are working on the right lines Indeed for a great landholder the selection and the supervision of his staff make up the principal duties that have to be performed And it must be admitted that many landholders neglect these duties Some lease the management of their villages for a fixed sum an arrangement that no doubt saves the landholder trouble at the moment but puts the tenants in the hands

of an outsider who in most cases tries merely to make what he can in the short time of his lease, and who not infrequently ruins the rent-paying power of a village by his exactions Such leases, which are known as thekas may be justifiable for outlying portions of an estate when their situation is such that the landholder or his agent cannot visit them freqnently, but in ordinary cases they have been rightly described as the negation of good management Some landholders, again, employ rent-collectors on nominal salaries with a tacit agreement that they will supplement these by what they can extract out of the tenants, a method that if persisted in may end by making the rent collector a richer man than his master No doubt it is difficult for a large landholder to look after his collectors, but it is his own interest that suffers if he does not and nothing can go seriously wrong if he chooses his staff carefully, pays them reasonably and sees that they are collecting only the fixed rents are giving receipts for all they collect and are accounting for the full de mand, either as colle ted or as left uncollected for stated and sufficient reasons A short personal inspection in the circle of each colle tor will enable him to satisfy himself that his work is being managed properly, and if he follows the custom of the country and gives individual tenants free access, he need find no difficulty in enforcing the maxims which we have laid down

The qualifications of a landholder to manage his own property, or of an agent to manage a large estate may be stated as follows He must be fairly active, and able to get about the estate, he must have an eye trained to observe details, and his mind must be alert and ready to under stand anything out of the common which he comes across Further, he should have a thorough knowledge of the capacities of the various soils in his estate, and also of the capacities of the different castes of cultivators, and so far

as possible of the individual cultivators with whom he has to deal If possible, he should add to this thorough knowledge of his own estate a general grasp of the principles of agriculture, sufficient to enable him to detect cases where existing resources are not being turned to the best advantage and to recognise the cause of the failure, whether it be the ignorance of the cultivators, or their poverty, or any other cause A general grasp of this kind cannot be obtained by reading a few text books on the subject it involves a systematic course of study, which must be obtained either at a regular agricultural school or college, or by working under an agent who himself possesses these attainments and is willing to train his assistant

At the present day agents with these qualifications are hardly to be found, but with increased facilities for agricultural education the supply will increase if the greater landholders show a disposition to employ them In the meantime it may often be the interest of a large landholder to choose one of his relatives and send him to school or college to receive the necessary training, and it is invariably a duty which a landholder owes to his family and his estate to train his successor in the art of management A young man succeeding to a well managed estate may ruin it in a very few years by sheer ignorance and thoughtlessness, and it is obviously the landholder's duty to take what precautions he can against the ruin of his family

Improvements

Supposing, then, that the landholder or agent is competent to manage his estate, his particular attention will be given to detecting all cases where the produce is less in quantity or in value than it might otherwise be and to remedying the defects which he may find, in other words he will always be on the look out for a chance of making

improvements Now we have seen in the preceding chapters that the ordinary cultivator is not lacking in skill, knowledge or readiness to take pains, but that he is hampered in many ways in making the best use of his land and labour The chief defects have been pointed out want of drainage want of water want of good seed want of implements for special purposes inferior cattle scarcity of fuel insufficient facilities for marketing defective processes for preparing products and want of means to cope with diseases are perhaps the commonest In all these matters the landholder can assist him, and he can also give him a chance of seeing how things are done in other localities leaving him to adopt any of the practices which he thinks will be advantageous We cannot discuss all these subjects in detail but must confine ourselves to stating a few general principles that should be borne in mind

Improvements made by cultivators.

In the first place it is almost always better to let a cultivator make an improvement for himself than to make it for him, he will spend less money on it, and he has a direct interest in making it as effective as possible. This principle applies to all improvements which are intended mainly for the benefit of a single holding thus it is usually better to lend money to cultivators who want to improve their stock of cattle than to make elaborate arrangements for importing cattle for their use Again it is much better for the cultivator to make a well for his holding as indeed he usually has a legal right to do By all means let the landholder assist him with clay and fuel, or bear the cost of any preliminary boring that may be necessary and advance him part of the cost if he requires it but the actual work is best done by the cultivator himself and it is certain to be done very much cheaper

Indirect income from improvements

Secondly, it is very unwise to make only those improvements which will bring in a direct money income, an improvement may pay in other ways For instance a well sunk on a tenant's holding may secure that the rent is paid regularly instead of having to be remitted whenever the season is unfavourable It may even happen that the sacrifice of immediate income may be a benefit in the long run a point that may be illustrated in connection with the question of fuel supply We have seen that much of the dung is regularly burnt to the great loss of the community as a whole and of the landholder and cultivator in particular and the only way of avoiding this loss is to increase the supply of other fuel To do this is a difficult matter and hardly any landholder is in a position to supply all the fuel that is needed but a good deal can be done in a small way by encouraging the growth of quick growing trees and shrubs wherever there is room on the banks of tanks on the tops of embankments among the larger trees in groves and so on as well as by regulating the use of dhak and other jungles that may exist on the estate A few land holders instead of selling off the firewood produced in their jungles have allowed their cultivators to cut it over in blocks year by year, at the same time agreeing with them that they shall not sell the dung so saved but shall pot it on their fields, and those who have followed this policy consider that on the whole it has paid them much better than if they had sold off the firewood periodically in the usual way It would be futile to suggest that this or any other, policy should be adopted in estates as a general rule the question must be worked out for himself by each land holder and the resources of the estate utilised as far as possible

Demonstrations.

Thirdly, the cultivator, assuming him to be a man of average capacity, knows an improvement when he sees it, but to see it takes some time For instance, it is not enough to show him a new type of cane mill standing idle, but he must have a chance of seeing it at work for a whole season or perhaps more, before he can make up his mind as to its advantages So, too, he must see a new kind of crop growing for two or three years before he is satisfied that it will suit his holding If then a landholder wishes to show his tenants new crops, or implements, or processes, which he thinks better than those in use on his estate, he will require a small demonstration farm, where the novelties shall be regularly on view Now in many parts of the provinces it is already customary for the landholder to cultivate some of his own land, often for amusement almost as much as for profit, and there is no reason why, when the landholder or his agent is competent, this home farm, or sir as it is called should not be developed into a demonstration farm, which would add greatly to the interest of the landholder in this immediate surroundings, and at the same time would occasionally introduce new and valuable improvements on the estate

Estate factories.

Lastly we may recur to the question of improving the processes of preparing various products for the market. It seems to us that there is room for a profitable extension of the landholder s exertions in this respect Every large estate might work up its own products for the market, thus securing a higher quality of product, and realizing a better price, which would be shared between the actual cultivator and the estate factory The equipment of such a factory would depend on the nature of the products to be handled, and one important source of economy would lie in the fact that the power required could be supplied from a single

cour e and applied to various proces e according to the eason. There might be for instance machinery for ginning and baling cotton, for hulling rice, for baling hemp, for pressing oilseeds, for refining sugar (which would have been prepared roughly in the field by improved boiling pans len out by the e tate) for cleaning the seed to be u ed next sea on and for any other proce es that might have to be gone through. O cour e such an estate fac ory would need an expert manager and the landholder would have to be careful that the tenant were trea ed fairly and not oppressed as they were by so many indigo factories, but with rea onable pre autions the con ern ought to be a hnan ial succes and at the same time increase materially the re ources of the cultiva or

Developments of this kin l are, however, po sible only on the larger estates, and with landholders who are suffi ciently educated to realize the advan ages which they derive from ju t treatment of their tenan s. For maller estates and where the land ho ders have no reached tha stage of education, there is still ample cope for more mode t improvement there are wells to be unk depre ion to be drained, ravines o be embanked and terra ed, the fuel supply to be husbanded and perhaps in reased village roads to be maintained and improved and market to be devel oped, ome of these will pay directly for the expenditure, while all alike if planned with judgement and carried out with economy, will in rea e the rent paying power of the ten nts, and thus add to the tability of the rent roll of the estate.

No e to Chapter XIII.

The organisat on of the agricultural d partmen has made the introduct on o improvemen s very much eas er than was the case when the firs edi ion of this book was i sued, if a landholder wishes to improve his estate, the first step should be to consult the offi er in charge o. the c.rcle where his estate l.es.

Chapter XIV—TRADE IN AGRICULTURAL PRODUCE

The food supply.

We have already seen that the main object of the cultivator is to feed himself and have something over In ordinary years the provinces, taken as a whole, achieve this object, and the surplus produce is enormous though the share of a single cultivator is small A glance at the general course of trade is valuable, as it enables us to realise something of the relative importance of different crops to the provinces as a whole Of course the ordinary food grains, which constitute the largest item in the whole produce, do not bulk largely in the trade returns, for they are mostly consumed in the village, or at least in the locality where they are produced the ideal of the ordinary cultivator appears to be that when his harvest is complete he should have at least six months' store of food in hand, enough, that is, to feed his family and to pay his labourers their wages until the next harvest is ready It is true that many cultivators are never in this position, but in their case the minimum stock has to be kept for them by the village grain-dealer who finances them, so that the total stock kept in the country for the eight or nine million families is enormous Speaking very roughly, for no precision is attainable in these matters, a ton of grain will support a family of five for a year, so that the minimum of six months stock represents from four to five million tons, worth, say, fifteen crores at ordinary prices, or, in other words, the provinces would require about thirty crores' worth of grain in an ordinary year, if no classes consumed any other form of food We give these figures merely as an indication of the proportion which the home consumption bears to the trade with other provinces, and with the ready admission that they may be in error by twenty five per cent in either direction, they at least help us to

understand something of the greatness of the agricultural interest.

Exports.

Now when a few seasons have been good, the stock of common food in the provinces rises above the minimum, and many individuals find themselves in a position to put more of their land under money bringing crops when this is the case *there is an enormous surplus for export.* Thus in a fairly prosperous year the provinces may export on balance five crores' worth of oil seeds or more and nearly the same quantity of grain These are the two heads under which the fluctuations in trade are greatest, in a year when famine conditions have prevailed *the exports of oilseeds* may fall to one or two crores, while grain may have to be imported on an enormous scale to meet the local deficiency.

Next to grain and oilseeds, we may take the figures of raw cotton, sugar and opium These do not fluctuate to anything like the same extent, varying from about 1½ to 3 crores according to the season Cotton does not fail very greatly in a famine because, as we shall see, it thrives best on a small quantity of rain but it may fail seriously in a year when the rains are so late as to prevent sowings Opium is produced only on irrigated land, and is thus comparatively independent of the seasons, but the exports necessarily depend on the policy of Government which controls the entire stock and determines the area that is sown. The loss of sugar in bad years may be very great, but at the same time the home consumption is reduced and the sugar placed on the market instead, so that the exports do not fall to the same extent

Lastly, we may notice two other classes of exports, hides and ghi, both of which have the peculiarity of increasing in years of distress. In the case of hides this is due to the mortality among the starved cattle, while in the case of ghi it is the result of enforced economy, ghi being a very

common luxury and being largely consumed in prosperous years, but becoming beyond the reach of many families when grain is very dear and there is little in store

Imports.

If we turn now to look at the figures of imports, we find that there are very few things imported in large quantities cotton goods metals, kerosine oil and salt are all that we need notice Cotton goods are by far the most important as they supply almost the whole population with everything that they wear In a prosperous year as much as six crores worth of these goods may be imported on balance but in hard times people economise greatly in this kind of expenditure and the imports may fall by *as much as one half* *The metals in demand are brass and* copper which are used for making the household utensils that form such a large part of the specialized wealth of the people in good years as much as half a crore s worth of these metals may be imported on balance, while in famine times the trade comes almost to a standstill Kerosine oil is steadily coming into use among the people, and something like half a crore s worth is imported in an ordinary year while of salt over one crore s worth is required which may be reduced by one quarter in times of famine Besides the e staple imports there are of course large numbers of articles imported in considerable quantities, but none of them are individually important enough to be mentioned in a general summary of this kind. There is however one peculiarity which must be noticed, and that is the steady absorption of gold and silver Much of this is hoarded in the form of cash, the rest is kept in the form of jewellery, which indeed serves much the same purpose, being regularly pawned or sold in bad times. The amount of treasure absorbed in this way is practically unknown, but it mounts up to crores in a favourable year

Summary.

On the whole, then, we may say that the people of the provinces draw most of their cash income from sugar and opium (which are fairly stable sources), from cotton (which depends more on the seasons), and from grain and oil seeds, where the influence of the season is very pronounced. They spend far more on cotton goods than on anything else, and they also import salt, which is a necessity, and kerosine oil and metals, which may be classed either as comforts or as luxuries the rest of their spare cash goes on personal expenditure of various kinds and on adding to their savings in gold and silver Salt is the only absolute necessary which they import in large quantities for they could be clothed from the grown cotton in the provinces if they did not prefer cloth of a better quality than it produces and the place of kerosine oil could be taken by any of the vegetable oils which it is gradually superseding

Note to Chapter XIV

Readers who may wish to pursue this subject further will find all the materials in the Annual Reports on the Inland Trade of the Provinces published by the Superintendent of the Government Press at Allahabad These reports are not recommended for the general reader

Part II.

Chapter XV.—THE AGRICULTURAL REGIONS OF THE PROVINCES

Introductory.

The description contained in the foregoing chapters applies primarily to the country between the Jumna and the Himalayas, which is the productive part of the provinces. This extensive plain is not, however, altogether homogeneous, but contains several well marked types of country which it is the object of the present chapter to describe. The country south of the Jumna forms the subject of the next chapter; as regards the third division of the provinces—the Himalayan tract—we propose to say very little. What cultivation is to be found lies in patches on the hillsides or in the valleys, and almost every valley has its own peculiarities. The crops grown and the times of sowing and harvesting depend mainly on the altitude. Ordinarily each village endeavours to feed itself from its grain crops, the chief of which are rice, wheat and mandua, and to produce something for sale. Its market crop must as a rule be of small bulk in order to bear the cost of carriage and is usually a spice such as red pepper, but in accessible places potatoes are largely grown and there is considerable scope for producing fruit and vegetables for the markets of the plains. The area of which cultivation is possible is a very small proportion of the whole, and the vicissitudes of season do not affect materially the economic position of the rest of the provinces. We may proceed therefore to consider the different regions that are to be found in the plains.

Lowlands.

The first distinction that we notice is between the lowlands along the rivers and the rest of the plains These lowlands are known by various names such as khadir, kachhar, or tarai they vary in extent from the strip of land a few yards broad which we find along the smaller streams to the ten mile khadir of the Jumna in Bulandshahr, or the equally extensive lowland of the Gogra These lowlands include all classes of natural soils from very heavy clays to loose sand the most marked characteristic of the productive soils is their relatively small depth, coarse sterile sand is almost uniformly found a short distance below the surface, and the productivity of the land depends very largely on the depth of loam or clay, which must often be measured in inches

The distinguishing feature of the lowlands is their wetness, for during the rains they are for the most part either swamps or actually under water, and during the cold weather, though the surface may be dry, the soil just below it is moist, and water can be found by digging a hole a few feet deep In these tracts, then, either no kharif is sown or it is sown largely as a speculation a great variety of seed being often sown in the same field in the hope that something or other will give a good return. The hope is often not realised, but the speculation is cheap, as the coarsest crops are sown and the tillage is reduced to a minimum Rabi, on the other hand, is a fairly secure crop once it is sown, as floods in the winter are almost unknown, and there is very little danger of loss from drought but tillage is very difficult as the land stays wet until late in the season, and time can be found for only one or two hurried ploughings In fairly dry seasons these lowlands may be most productive, but in wet years they are very dangerous sometimes the land is too wet to sow, if sown the crops are specially liable to

disease, and worst of all the defective drainage (due to the unusual fulness of the river which should act as a drain) may allow reh to come to the surface and render the land hopelessly barren for the time being Again, when cultivation has been prevented by any cause, the land gets rapidly covered with coarse grasses and shrubs which involve heavy expenditure in clearing the ground for the next crop This scrub jungle too shelters various animals which do great harm to the crops growing near them, pig and deer are the worst offenders, though occa sionally serious injury is caused by herds of cattle that have run wild Residence in the khadir is unpopular with most classes as it is usually unhealthy and the houses may be flooded or even washed completely away Except there fore for a few castes who are more or less at home in a flood, the cultivators usually live on the upland and come down to the khadir to till hence good soil is almost unknown, little or no manure is used and the land does not get the care that is given to fields within easy reach of the village

Apart from the risk attendant on wet seasons or on the presence of wild animals, the lower parts of the lowland are at the mercy of the river itself Sometimes it may cut a wide channel through a block of fertile fields, and sometimes it may bury good loam several inches deep in barren sand On the other hand it may deposit an extreme ly fertile silt on what was previously bad soil, and it is practically impossible to say what a field will look like after the next flood It would therefore be waste of time to look ahead to the following season if the land is fit for cultivation a crop is taken from it with the minimum of expenditure if not, it is left to itself Thus the khadir usually shows blo ks of cultivation scattered through stretches of barren sand, or grass and scrub jungle, the latter is by no means valueless, as large numbers of cattle are grazed on it, and it may be the salvation of the

neighbouring cultivators if a drought has left them unable for the time being to provide fodder for their cattle There is little good timber to be found in country of this kind; babul grows freely, and considerable areas are covered with dhak, which is good for fuel if for nothing else

The foregoing description applies to the typical low-land, in some places land is found at an intermediate level low enough to hold plenty of water for the rabi, but high enough to escape serious floods This upper khadir, which may be seen to perfection in Budaun, is well populated, fertile and secure, though here too the crops will be inferior when there has been a succession of wet seasons

Divisions of the uplands.

The uplands may be divided into four main types according to the nature of the commonest soil The natural soils are not as a rule closely intermingled, it is very rare to find a field of sand between two fields of clay or *vice versâ* and the usual thing is to find the soil in bands, sometimes of considerable width, lying roughly parallel to the rivers Thus we get three types of country, the bhur, the dumat, and the matiyar, to which a fourth may be added to include the garden tracts near the towns

Bhur.

The bhur consists of a stretch of uneven sand the field boundaries are wide and overgrown with high, coarse grasses, nearly every field has an autumn crop of bajra mixed with pulses, and rabi is comparatively rare, and when sown is usually a mixture of barley and gram Irrigation is almost unknown, as wells cannot be made, and if they could the coarse soil would not retain the water long enough to be of use This is a description of the worst bhur, that which is only just culturable elsewhere we find soil which while still called bhur has more cohesion, is fairly level, and will hold some water. Such land may be very fertile if masonry wells are made and manure is freely

used, but if the cultivation is careless, the produce is almost limited in this case also to bajra and coarse pulses A marked feature of this superior bhur is its suitability for the mango, large and prolific groves of which are to be found in many places where it exists, indeed it may sometimes be remunerative to stop cultivating bhur and plant it with mangoes

Matiyar.

In marked contrast to the bhur are the heavy clay tracts The main feature of these tracts is the extent of barren stretches of the hard, compact soil which is known as usar and is not infrequently covered with the white efflorescence called reh The barren stretches are separated by blocks of rice fields the fields small in size, and the field boundaries unusually high and wide, in the rains such blocks are a stretch of bright green, but once the rice is off the ground most of the land is bare and the rest carries mainly poor crops of gram and linseed Wherever depressions exist in these tracts they fill with water in the rains and as the soil is too stiff to let the water drain away, it remains for a large part of the cold weather, such depressions are known as jhils Timber is rare in such tracts babul grows fairly, and occasionally nim and mohwa are to be found, but the bareness of the country is one of its most striking features

Dumat.

Intermediate between the clay and sandy tracts is the dumat or loam the typical landscape of the provinces It is usually well wooded mangoes being the commonest trees, the land bears an almost infinite variety of crops, those of the kharif being often of great height (maize, juar and sugarcane), while the low rabi crops, wheat, barley and pulses are broken by the darker green of the arhar and in places by the white expanse of the poppy fields

Garden tracts.

A fourth type of country is to be found in the tracts adjoining those towns which stand on fairly light soil Such soil is especially adapted to make the most of heavy manuring, as it is easily tilled and well drained, and the most skilful castes make full use of the supply of manure to be had from the town. Such land is hardly ever bare directly one crop is off the ground another is sown, and the diversity of crops is amazing While many towns have considerable areas of this type, perhaps the most striking are the potato grounds near Farrukhabad and the fruit and vegetable gardens round Lucknow

Distribution of soil tracts.

We have said above that the natural soils are to be found in bands lying roughly parallel to the rivers It is beyond the scope of this work to give the agricultural topography of the provinces in detail but we may illustrate this statement by a typical instance A journey from Cawnpore to Lucknow affords an excellent opportunity of studying the distribution of soil After crossing the Ganges bridge there is a stretch of typical lowland for about five miles, then the line rises through a narrow strip of broken bhur, then comes level bhur and dumat, and before we reach Unao we are in regular matiyar country This continues for twelve or fourteen miles, though it is broken near Ajgain station by an island of loam then comes dumat running into bhur as we come to the Sai Beyond the Sai there is bhur and light dumat about Haraun station but by the time Amausi is reached the country is again matiyar, which continues to the environs of Lucknow Here, if we leave the railway, we find that the light soil along the Gumti has been turned into garden land, so that this short journey gives a very fair epitome of the greater part of the plains

Other cross country journeys, such as those from Allah abad to Fyzabad or from Shukohabad to Farrukhabad show very similar features in some cases the band of clay soils may be missing, in others the strip of bhur is so narrow as to be barely noticeable, but as a general rule the further we go from a river the stiffer is the soil until we approach another river

Other tracts.

By far the greatest part of the plains comes under one of these classes khadir bhur matiyar, or dumat, or market gardens but there are a few special tracts that may be mentioned briefly Just below the Himalayas is a belt of country known as the bhabar mostly forest and so unhealthy that it is almost uninhabited The soil here is a thin deposit overlying a mass of boulders and gravel through which the water drains rapidly away The bulk of the cultivation is in the hands of hillmen who come down at the end of the rains and leave when they have harvested the rabi Below the bhabar is the tarai mostly heavy clay land much of it under forest The population is more settled than in the bhabar but the climate is very unhealthy and the crops are exposed to great damage from wild animals Along the line of the Jumna from Agra eastwards the soil differs in many places from that of the duab proper, being in fact a mixture of duab and Bundel khand soils It is poor land irrigation is often difficult as the wells are very deep and the grass known as *kans* is apt to spread if the land is left untilled We may also mention the ganjar a strip of land in Sitapur and Bara Banki lying between the Gogra and Chauka rivers It is of the khadir type but in the rains the streams of the two rivers unite and sweep down it, causing far more damage than the ordinary, slow moving floods of the lowlands

It must be remembered that in the brief descriptions we have given it has been possible only to indicate

the most striking features of each class of country almost every tract has its own characteristics which can be learned only by study and observation The upland tracts too pass into each other gradually so that it may often be difficult to say whether a particular field is just in the bhur or just out of it, but a broader survey show clearly enough the general line of division between the tracts

Rainfall tracts

We must now notice the natural divisions which result from the variations in the rainfall We have seen already (Chapter II) that the amount of rain decreases from east to west, and also from the hills to the Jumna, the result is that the districts north of the Jumna may be divided into two main sections, the submontane and the central

The submontane tract stretches from Saharanpur to Gorakhpur, its most striking feature is the dampness of the soil, so that irrigation for the rabi is required to a much less extent than further south, and in some localities is altogether unnecessary The soil gets heavier on the whole from west to east, and the most valuable crops are rice and sugarcane The extent of khadir land is another marked feature of this tract, as each river that emerges from the hills has a wide valley of its own. It might be thought that a tract so favoured in the matter of moisture would be particularly prosperous, but the water means fever and the northern part of the tract which adjoins the tarai is very unhealthy labour is therefore scarce and inefficient, cultivators are hard to procure and it is only the best managed estates that are prosperous.

Adjoining the submontane districts is south Rohilkhand, a small tract including Budaun, most of Shahjahanpur and parts of the neighbouring districts This tract too is damper, but there is more need of irrigation than in the submontane districts, while the climate is much healthier The dumat gives excellent wheat and sugarcane, and the

khadir of the Ganges is productive, but the khadir is bounded by a band of bhur running almost continuously from the south of Bijnor to Hardoi and presenting all the defects of such land in an aggravated form

East of this tract comes south Oudh including practically all Oudh south of the Gogra In this tract the parallel bands of matiyar dumat and bhur are most easily distinguished from the agricultural point of view its most striking features are the skill and energy of the cultivators and labourers and the splendid system of well irrigation The population is however very numerous and holdings are small so that much of the land is under the coarser and commoner crops

Still further east and keeping north of the Ganges we have most of the Benares division with which Azamgarh forms the tract usually spoken of as the eastern districts Here the soil is largely clay and rice is the great crop the country is overcrowded holdings are very small and the people are poor The hilly tract of Mirzapur lying south of the Ganges is entirely distinct from the rest of the division consisting mainly of light thin soils which support a scanty population and are still largely at the mercy of the rainfall The south east of Allahabad is of the same type

Now if we return to Saharanpur on the extreme north and follow the right bank of the Ganges we are in the duab proper between that river and the Jumna The upper portion of this from Saharanpur to Aligarh is the richest part of the country The soil is light and fertile holdings are large the people are well to do and the admirable system of canals enables them to make the most of their and All crops are grown but sugarcane wheat and (towards the south) cotton are the great features South and east from Aligarh to Cawnpore the duab is not so good there is more poor land and holdings are smaller

nor is the canal system so complete Sugarcane is very little grown, but wheat and cotton retain their importance Finally, from Cawnpore to Allahabad the country is much poorer; sandy along the north and on the south more like Bundelkhand The people are not well to-do valuable crops are more rarely grown and canal water has only recently been made available These three divisions of the duab are usually spoken of as upper, middle, and lower, they are of course continuous, and it is a matter of convenience where the dividing line is drawn, but as a matter of practice Aligarh is included in the upper duab and Cawnpore in the lower Muttra and Agra though lying in part beyond the Jumna are usually included in the middle duab, their special features need not detain us

CHAPTER XVI—BUNDELKHAND

As has been indicated in previous chapters the districts lying south of the Jumna differ widely in regard to agriculture from those lying to the north The difference consists partly in the habits of the people partly in the soil, and partly in the water supply The climate is generally of the same type as that of the duab, though the rainfall is apparently rather more liable to vary both in excess and in defect The people are perhaps less industrious than those who live north of the Jumna, and are readier to give up the struggle against adversity but it must be admitted that in their case the struggle is exceptionally severe, and their resources have until recently been scanty

Soils

The soils are altogether different from those with which we have hitherto had to do In the south of Banda and Hamirpur, and over a large portion of Jhansi the soil is not water borne at all, but consists of a few inches of crumbled rock lying on top of the rocks from which it has been

formed These areas are known as red soils from the prevailing colour of the land The thin layer of soil cannot hold water for any length of time, and a rabi crop is seldom sown on it an inferior millet is the usual kharif crop Even so the soil is too poor in plant food to stand continuous cropping and after it has been cultivated for two or three years the land is left fallow until a new store of food has gradually accumulated Interspersed among these tracts of poor soil, and generally close to village sites and situated in valleys between the low hills, are little oases of stable cultivation carefully manured and regularly watered from wells sunk in the solid rock and worked by Persian wheels

The south eastern portion of Banda and the south of Allahabad lie on the lowest and most northern platean of the Vindhya range This tract, locally called the patha, has much the same characteristics as that just described, but the climate is more unhealthy and the soil still thinner and poorer, only a very small proportion being cultivated.

To the north of the red soiled country and also in the south of Jhansi we again find soils that appear to have been deposited by the action of water, but they are distinct in appearance and character from those of the duab, and must be presumed to have had a different origin, probably the hills of Central India These areas are spoken of as black-soil country Four main types of these soils are recognised, which are known as mar, kabar, parwa and rakar These may be described as follows

Mar is a rich black* soil, soft and friable, which can be easily tilled when in proper condition, and may be very fertile Its best quality is that it retains an enormous quantity of water, so that if the rains have not been very

* Mar is frequently spoken of as black cotton soil. The name is inappropriate because it differs substantially from the black soils of Central India on which cotton is very widely grown, and as a matter of fact cotton is hardly ever grown on mar

deficient, wheat can be grown successfully and does not require irrigation If however the monsoon fails, and the soil is too hard to plough, nothing can be done without copi ous irrigation, such as is rarely possible On the other hand, when the rain at the end of the season has been excessive, there is often much difficulty in preparing a proper seed bed in the soaked soil

Kabar is also a dark soil, but not so dark as mar it is much stiffer and more difficult to work when wet it is a sticky mass that cannot be ploughed at all, and it dries exceedingly quickly at the same time splitting into hard blocks Thus its cultivation for the rabi is often a matter of difficulty, and it is left untilled if the rain has been either excessive or in considerable defect This soil can also grow good crops without irrigation provided it has been possible to prepare a seed bed

Parwa is a reddish or yellowish loam, resembling more nearly the soils of the duab in its behaviour towards water it can thus be irrigated successfully when water is to be had, and irrigation is usually required in the absence of adequate winter rains

As a rule the mar lies in level plains, where the surface is broken by streams, the mar passes into kabar and the kabar in turn passes into slopes of an inferior denuded soil called rakar bearing only the most inferior crops The rakar again passes into ravine land the extent of which is a distinctive feature of the country

In addition to these typical upland soils a stretch of fertile alluvial soil is often to be found along the margins of the rivers and streams These soils, which are known as kachhar and tari, are distinctly fertile but in some places they share the risk of such soils elsewhere being liable to be cut away or buried under sand by some vagary of the river On the other hand it is very unlikely that they will suffer from drought.

Irrigation.

Next as regards facilities for irrigation. In ordinary years and for ordinary crops mar and kabar do not require irrigation but purwa does, in dry seasons the two former require copious supplies to enable a seed bed to be prepared Much progress has been made in recent years in constructing canals to supply the needs of the country, and the area that can be sown in a drought is now very much greater than would have been possible ten years ago It must be remembered however that though during and just after the rains there is an enormous supply of water in the river which supply the canals the supply stops abruptly in the winter, and there is a limit to the amount that can be stored in reservoirs The rivers that come from the Himalayas have a perennial supply in the melting snow from the higher mountains, and it is this that makes them such an unfailing resource in years when the rains have been inadequate but the Bundelkhand canals are themselves dependent on the rains of each season if there were no rain at all they would be almost useless, and when the fall late in the season has been seriously deficient the supply in the reservoirs may give out before the rabi irrigation is completed. Notwithstanding this defect the construction of the canals has materially changed the economic condition of the country

Wells

The want of wells is the most striking deficiency of the country when it is compared with the land north of the Jumna Wells are fairly numerous in parts of Jhansi, in the south of Hamirpur, and in a few isolated localities elsewhere, but in the greater part of the country, including most of Banda, Hamirpur, and Jalaun, the depth to water is so great, varying from 50 to 100 feet in round numbers, that the cost and labour of raising water is almost

prohibitive while the supply of water is often very deficient and is sometimes inadequate even for domestic purpose.

Lakes

In the hilly country to the south the lakes constructed by the Chandels in early times by throwing embankments across the lower extremities of valleys have been utilised for irrigation and a large number of similar lakes or reservoirs has been constructed in recent years The larger lakes irrigate considerable areas while even if there is little direct irrigation the effect of the reservoirs is seen in the greatly increased supply of water in the land lying below them and their beds can be successfully cultivated when the water has been drawn off

Embankments

In the black-soil tracts very great improvement can be effected by embanking the fields so as to prevent the rain water from running off the surface It then soaks into the land which as we have seen can hold a large quantity of water and fields so embanked can be sown with rabi in seasons when unbanked land is far too dry to be tilled Embankments of this kind which are called bandhiya have been made in large numbers during recent years in most cases with the aid of a Government loan but there is still scope for very great extension and where canal water cannot be made available these works are practically the only form of improvement that can be recommended

Crops

With soils such as have been described and with so little water available it follows naturally that the crops grown are on the whole much inferior to what we have seen in the duab the most paying crops such as sugarcane are hardly seen at all and the outturn of crops like wheat is not more than two-thirds of what is obtained in the duab In ordinary times the kharif area is nearly double that of the

rabi · the food crops grown in the former are practically limited to juar, bajra, kodon and arhar, with rice in some localities, and the only other crops of importance are til and cotton In the rabi, gram occupies by far the largest area wheat used to be grown more commonly than is the case now, and linseed is the only other first-class staple Thus the cropping is much less varied than in the duab, so that a calamity affecting any one of the principal crops is all the more seriously felt by the people

Calamities

It is comparatively rare for the country to have a really favourable season If the rains are deficient, the kharif suffers, and there is much difficulty in preparing a rabi seed bed while if the rains are excessive, the kharif suffers to an equal degree, and the rabi seed bed is again a source of trouble If there is no cold weather rain, the crops on the light soils are destroyed if there is heavy rain, the wheat and linseed are ruined by fungoid diseases, which seem to do more harm in Bundelkhand than in the duab With a series of years of heavy rainfall and unfavourable ploughing seasons the heavier soils are liable to be overrun with kans (vide Chapter X), and once this weed is established the cultivator does not attempt to cope with it, but leaves it to wear itself out, a process of from ten to twenty years Epidemic cattle disease is peculiarly fatal in the Bundelkhand districts, and the climate does not conduce to sustained efficiency among the population

Advantages.

These numerous disadvantages are to a certain extent compensated · thus cotton thrives in a season of short rainfall, and in the south of the tract the wild mohwa trees yield a fruit that helps to feed the people for a considerable period, while there are occasional seasons of exceptional productivity when large areas give enormous yields with

little trouble beyond that of harvesting. The cultivator's chief advantage, however, is the lowness of rents and the absence of competition for land The landholder has a very slight hold over him, and if an attempt is made to raise his rent to a sum which he thinks excessive, or to collect it with a strictness he considers unjust, he is ready to abandon his holding, secure of finding land within a short distance

Progress.

A few words may be said about the progress of Bundelkhand during recent years The last decade of the nineteenth century was marked by a succession of disasters, in the course of which a considerable proportion of the agricultural capital of the country was lost and the entire population was greatly impoverished Recent years have seen a considerable improvement, due in part to the provision of material facilities such as the new canals and the offer of loans for agricultural purposes, and in part to the policy adopted by the revenue administration The recognition of the fundamental principle that Bundelkhand requires strong cultivating communities and not absentee landholders has had far-reaching effects the debts of the landholders were liquidated under special legislation so that land should not be sold for existing debts, while for the future the powers of sale were greatly restricted At the same time the methods of assessing and collecting the revenue were modified so as to make sure that no excessive demand should be made in unfavourable seasons. The result of these various measures has been an undoubted increase in the capital available for agricultural use, and with capital available the people have shown more aptitude to make the most of their resources and to struggle against adversity than might have been expected from their past history.

Chapter XVII —THE PRINCIPAL CROPS—KHARIF FOOD CROPS

In describing the crops grown the easiest order to follow is that in which they are sown We shall therefore consider first the kharif crops which are sown from June to August then the rabi which are sown mainly in October and November and lastly the crops which are not sown at either of these seasons It is also convenient to class the crops as food and non food the former being those whose main produce is eaten by man or animal Food crops again are usually divided into cereals pulses and miscellaneous crops while non food crops are classed according to the nature of their principal product as oil seeds dyes fibres drugs and so on

A word of warning may be said as to the outturns of the different crops The figures given in the text are supported in all cases by a *certain amount of evidence* but it is exceedingly difficult to find out the real yield over a considerable area and they are probably below the mark in a *substantial number of cases*

Nomenclature

Before beginning to describe the crops in detail it is necessary to come to an understanding as to the names to be used We shall speak of a crop by its English name when one is in common use but in all other cases the commonest vernacular name will be used Apart from these two sets of names there is yet a third to be considered the scientific name it is useful to have this for reference mainly because the vernacular names differ in some cases from place to place and also because one sometimes meets with people who know the scientific name but not that which is common in this part of the world

Botanists have a complicated system of naming plants in accordance with their classification but we need

consider only three of their divisions, the genus, the species, and the variety Any distinct plant is a species thus juar is a species, gram is a species, barley is a species, and so on Those species which resemble each other fairly closely are grouped together as a genus, to which a separate name is given Botanists then speak of any particular plant by the name of its genus, adding a second name to distinguish the particular species Thus when we find the wheat commonly grown in these provinces spoken of as *Triticum sativum*, it means that the wheat as classed is belonging to the genus *triticum*, and that the word *sativum* has been agreed on to distinguish it from the other plants with which it has been classed. Unfortunately botanists have not always agreed on the names to be used, and one may be referred to under different names in books written at different periods, the most confusing instances of this unfortunate want of agreement will be indicated in notes

All plants in a species are not exactly the same in every respect there is a strong general likeness with differences in detail, and plants differing in detail in this way are usually spoken of as varieties Thus some wheat may be seen with long green spikes extending above the ears while other plants have very short spikes, or perhaps none at all . these are usually spoken of as different varieties, bearded in the one case, bald in the other Or again the grain of some juar is cream white in colour, while that of other juars is distinctly red these again are distinct varieties The question of varieties is of great practical interest to the cultivator we shall see later on that with some crops the varieties differ greatly in the value of their produce in their hardiness, and so on, and the cultivator's object is to grow the best paying variety for which his climate and soil are suited We shall find that in the case of many crops the varieties have not yet been studied in detail, in such cases it is safe to assume that the variety

grown in any locality is well suited to the circumstances in which it is grown, but it is never safe to assume that no other variety would do better, as it is quite possible that there is in some distant country a variety that would do exceedingly well if it could be tried And further it is important to know that man can, and does, produce new varieties to order so that there is always a prospect of improving the kind of crops grown in any place, for, even if they are the best of their kind, a still better kind may be produced at any time

In the case of many, perhaps most, of the common crops, the seed sown by cultivators is a mixture of several varieties, and the produce accordingly is not uniform in quality and is therefore unsuited to an external market which demands uniformity

As we have indicated above, we divide the kharif crops into five classes, three of which are food crops, cereals, pulses and miscellaneous, to which we add the oil-seeds and the fibres The cereals fall into three groups, maize, which stands by itself, the rices, of which there is an enormous number of varieties, and the millets, of which several distinct species are grown

Maize, Zea mays. Vernacular, Makka or Makai
(Also spoken of in parts of Oudh as *bara juar*)

Maize grows about four or five feet high, with broad leaves much broader than those of juar which it otherwise most closely resembles in its earlier stages It flowers in two places, the male flower being at the extreme top of the plant in a series of small branches, while one or more female flowers appear lower down on the stem in the form of tufts of hair often of a reddish colour Just below these tufts the grain forms, each grain resting in a woody socket and the whole cob being wrapped in a sheath of leaves. Only one stem rises from each seed, and roots may often be noticed starting downwards from the stem above the

level of the ground Ordinarily one or at the most two cobs form on each stem

Maize ripens in a very short time and therefore is of peculiar value as being one of the first crops to come in for food hence it is sown very early, as soon as possible after the rains break, while in the canal districts the practice of sowing it before the rains after irrigating the soil has spread rapidly in recent years It requires fairly good land to do well, and is very commonly grown close to the village often receiving manure several ploughings are as a rule necessary Each plant requires a good deal of space, and some cultivators dibble the seeds in separately, but more usually it is sown either broadcast or in drills behind the plough about twelve pounds of seeds going to the acre With so much ground left vacant between the plants, weeds come up in great numbers along with the seeds, and have to be carefully removed, while each plant has to have a little earth heaped round it to prevent it falling over Cultivation is therefore a laborious business The crop is irrigated only if sown before the rains or when a break has set in and the plants are beginning to suffer As soon as the grain in the cobs has matured, the cobs are cut from the stalks which are left to stand in the field, and set out to dry in the sun, and when they are quite dry the grain can be beaten out or scraped off * It is usually a large bright yellow grain which may in favourable years amount to 1 500 pounds per acre, or even more, but the average yield is estimated at about 1 000 pounds It is not in very high favour as a food, but as it is ready for eating early in September when the stock of food saved from the previous rabi is running low, its success is a most important matter Sometimes instead of waiting till the seed is quite mature the cobs are picked rather earlier and sold as they are to

* Machines for this purpose are now available and can be used economically when a large area has to be dealt with

be roasted for food this is the more profitable course if the crop has ripened very early, as then the price for a cob is very high, but it does not pay when the regular harvest has set in

Maize is distinctly a delicate plant, and therefore its cultivation is somewhat risky Its roots do not go deep but lie close under the surface, and as it requires very large quantities of water, and draws its supplies from a small depth, it suffers from a break in the rains more quickly than almost any other crop On the other hand, water logging is equally disastrous the crop is never sown in low lying fields, and if any water collects in places it must be drained off at once, or the plant will begin to suffer The shallowness of its roots is also accountable for the ease with which plants are blown over and broken, and it is this that makes the expensive earthing up necessary As soon as the cobs have formed they have to be protected from porcupines, squirrels, parrots and jackals, and particularly from thieves, so that the crop has to be watched regularly On the other hand, maize has the great advantage that it is almost beyond danger from a dry September We have seen in an earlier chapter that failure of the rains in September may turn a promising season into one of distress, or even famine the earliness with which maize ripens renders it safe from this danger provided its sowing has not been delayed.

Maize is found in most parts of the provinces, but it is commonest in the Meerut and Fyzabad divisions it is almost unknown in the black soil tracts of Bundelkhand The area under the crop has extended rapidly in recent years, and it is becoming popular in many localities where formerly it was almost unknown Apart from the common type with bright yellow seeds, there is a distinct variety grown at Jaunpur with waxy seeds the whole plant is larger than in the common type, the cobs far larger

and the produce greater: on the other hand, it does not mature so quickly. One great advantage of the common maize is that it leaves the ground vacant in time for sowing a rabi crop, while with the Jaunpur variety there is not time for any but rough tillage Other varieties also exist but they have not yet been studied in detail

The stalks are nutritious fodder if cut while green, but they become so hard and woody that they are of little use except for thatching or fuel

Rice. *Oryza sativa* Vernacular, Dhan.

The number of varieties of rice is very large, and they have not been studied in much detail They fall, however, into two main groups, those that are sown broadcast in the field and ripen in less than three months (called *bhadoi* or *kuari*), and those which are sown in nurseries, then transplanted into the fields, and mature in from four to five months Transplanted rice is usually spoken of as *jarhan*, and the finer varieties, which command remarkably high prices, are kept carefully apart and not mixed with others All alike are bright green plants of height varying from two to four feet, with the grain arranged loosely on long feathery ears. and all have the remarkable character that they do not require much air in the soil, while their consumption of water is so great that they grow best when the ground is thoroughly saturated, or even under water. For this reason the crop is grown only on the clays and heaviest loams which are practically undrained and hold the rainwater at their surface.

Broadcasted rice is sown as soon as possible after the rains break, the land is ploughed two or three times, and the ploughs may be seen working almost under water when the first rain has been heavy Sometimes after an early fall of rain the seed is sown while the ground is still very dry. if so, it does not germinate but remains in the ground till more rain falls, the

object of this practice is to save time, for the crop comes up after the first regular rain when other fields are only being ploughed The seed is sown fairly thickly, about 80 lbs going to the acre, and the young plants have to be weeded carefully. This done they need no more attention unless there is a long break in the rains, when they are irrigated from streams, canals or ponds, whichever may be available Wells are practically useless in this case, as the small flow of water that can be raised from them is not enough for the crop In August or September the rice ripens, and the plants are cut by the sickle, and then usually beaten to get the grain out of the ear The grain so obtained is enclosed in a hard husk, which is separated by pounding in a mortar the product is the well known white rice which is called *chawal* The husks are useful food for cattle if there is enough of them The outturn of unhusked rice appears to vary from 800 to 1,000 lbs per acre, of which about one quarter represents the weight of the husk

Transplanted rice is first sown very thickly in small plots of highly manured land when the seedlings are about a foot high, usually about the beginning of August, they are taken up and planted out in the field in regular lines The field must be under water, or at least thoroughly soaked, when this operation is carried out If conditions are favourable, each plant, of which from two to six are usually planted together, sends up a great number of stems, which develop far more freely than when the plants are sown broadcast The heavy crop consumes enormous quantities of water, and in dry weather irrigation is necessary weeding has also to be done if the land is not free from weeds The crop ripens usually in November, and is harvested in the same way as broadcasted rice, the outturn is probably from 1,200 to 1,400 lbs to the acre, and the quality of the rice is better, commanding

much higher prices Thus it pays to grow transplanted rice though the cost of cultivation is more than twice as high as the broadcasted varieties, provided the weather is suitable, but it is much the more speculative crop of the two

Early rice is fairly secure, provided there is good rain in July and August, and it suffers very little from excess of rain unless the plants are practically washed out of the ground It does not suffer greatly from pests except occasionally from caterpillars when the weather favours their multiplication Later rice too is hardly ever damaged by excess of rain, but any deficiency is a serious matter To begin with, if there is a break early in August, transplantation is much delayed and thus part of the growing season is lost then any deficiency of rain in September causes serious loss unless where a great deal of water is available, as where the land can be flushed from the canal With a really dry September the crop is completely lost in most places, for the water that has accumulated in the tanks and swamps is nearly all used up by the end of the month and the crop withers in October The rice sapper too, which usually appears at the end of August, does far more harm to the transplanted rice than to the broadcasted rice which is then ripening

Rice is grown only where there is a good chance of getting enough water Thus it is the principal crop in the divisions of Fyzabad Gorakhpur and Benares, while superior qualities are largely grown in some places where canal water is available On the other hand, it is almost unknown in the dry districts of Muttra and Agra, as well as in large parts of Bundelkhand

Rice straw, which is known as *pial*, is exceedingly poor fodder, and cattle eat it only when they can get

nothing else which is unfortunately often their position in rice districts

Millets

There are two types of millets (1) *juar* and *bajra* which are tall plants growing from six feet to eight or more and (2) the small millets *mandua kodon* and so on which grow only from two or three feet

Juar Andropogon sorghum *

This is a tall erect plant with broad dark green leaves and the grain carried on a single large head growing from the top of the stem as the grain matures this head usually bends over with the weight Juar is the commonest kharif crop in almost all places where rice is not staple it is grown usually on loam or even clay rarely on the lightest soils it does not get very much in the way of manure and from two to four ploughings are usually considered sufficient, it is not irrigated unless there has been a break in the rains long enough to dry up the land. It is sown in July as soon as the earliest sowings (cotton maize &c) have been finished The crop has to be weeded and it is a common practice to plough the field when the plants are about a foot high thus loosening the earth where it may have been caked by the rain As a rule juar is not sown alone but is mixed with arhar and some of the small pulses but it grows much faster than these crops and soon becomes the predominant feature in the field As soon as the grain begins to form the crop has to be watched as birds may do a great deal of mischief by picking out the grain from the head It is usually ripe in November when the heads are cut with sickles and the grain trodden out by bullocks very often the best heads are picked out and set aside for the next year's seed (vide Chapter V) The outturn of

* Juar has also been called *Holcus orglum* and *Sorghum vulga e*

grain when the juar is sown by itself is probably nearly six hundred pounds to the acre while when arhar and other crops are sown in the same field it is perhaps from four to five hundred pounds The grain is one of the staple foods of the poorer classes during a large part of the year

The great danger to juar is an early cessation of the rains showers in September are essential if grain is to be matured It suffers also from a fungus which feeds on the grain and may be recognised by its leaving a mass of black powder where the grain should be this disease which is known as smut can be avoided if before sowing the seed is treated with copper sulphate (nila thota) The borers also do great harm by settling in the stem and consuming the supplies of food for the seed and fungus on the leaves is very common but does not apparently cause much loss in ordinary cases Apart from drought the greatest injury is likely to result from heavy wind and rain at the end of September or early in October when the plant is in flower the flowers are open and exposed from their position and the rain prevents them being fertilised so that little or no grain sets In its earlier stages juar can stand a great deal of rain provided the land is not actually under water

The stems of the plant are an excellent fodder and form the main stay of the cattle from December to April being cropped into short lengths as required In the Meerut division and to a less extent elsewhere juar is sown only for fodder In this case it is sown as early as possible and to an increasing extent with irrigation before the rains break manure is often applied no other crop is mixed with it and the seed is sown much closer together The fodder is cut as required for use and a second smaller crop or even a third can be obtained in favourable weather from the patches that are cut earliest This supply of

fodder coming at a time when that from the rabi is almost exhausted is of the utmost benefit

The number of varieties is large, the differences consist partly in the size of the plants partly in the colour of the grain and partly in its arrangement on the head

Bajra. Pennisetum typhoideum.

In its earlier stages bajra has a general resemblance to juar but the stem is thinner and the leaf narrower The head is distinctly different being a long narrow spike rather like the head of a bulrush with the grains packed closely together on it It is usually sown on poor sandy soils with no manure and is hardly ever irrigated. The tillage is rough and as a rule the seed is sown broadcast mixed with arhar and one of the small pulses. Bajra can be sown a good deal later than juar and so occasionally replaces it when sowings have been delayed The crop is weeded and sometimes ploughed over in the same way as juar and then needs no more attention till the ears begin to set grain when it must be watched to keep the birds off It ripens rather earlier than juar that is towards the end of October and is harvested in the same way The outturn is less about 500 lbs of grain when the crop is sown alone and 400 to 450 when sown with arhar The grain is one of the chief foods of the poorer classes when people have the choice they eat bajra in the cold weather and juar in the hot as they find the former a more heating food

Bajra is rather deeper rooted than juar which is probably why it is always sown on the sandy soils it is scarcely ever exposed to danger from water logging as the sandy soils drain quickly but it may be a total loss if September is dry The flowers are very much exposed and if rain falls at the end of September or in the beginning of October fertilisation is very much interfered with

* Bajra is also called *Pennicilaria spicata* and *Panicum spicatum.*

and the outturn may be greatly reduced when the rain has been heavy and accompanied by strong wind, head after head may be found in a field with scarcely a single grain on it It is also occasionally attacked by fungi in the ears or on the leaves

The stalks are used as fodder in the same way as juar, but they are much less nutritious and the crop is rarely grown for fodder alone. The crop is grown most commonly in the Agra and Rohilkhand divisions and is very rare in the east of the provinces There are some varieties, but they have not yet been fully studied

Small Millets.

There are four common small millets, of which the commonest names are *mandua kodon sawan* and *kakun*, the names, however, vary greatly from place to place Sawan, a kharif crop must not be confused with the hot weather millet which goes by the same name in parts of Oudh, but which is usually called chehna

Mandua. Eleusine coracana

Mandua is often spoken of as makra. It is a great staple in the hills, but in the plains though grown in many places it is common only in Oudh and the eastern districts The plant grows from two to four feet high and looks like an erect broad leaved grass, the seed is carried on a head consisting of rather bushy spikes standing erect on the stem. It prefers light soils and is sown as early as possible, usually with slight tillage, sometimes, however, it is sown in nurseries and transplanted in the same way as rice. It is weeded but gets no other attention, and matures very rapidly, ripening usually in August and giving a heavy outturn of grain, often 1 000 lbs per acre or upwards But though the yield is heavy it is not a popular food, and no one eats it who can get anything more palatable.

Mandua does best with a light rainfall and suffers severely from any excess this is probably one reason why it is sown largely in some of the rice districts, as a sort of insurance in case the season may be too dry for rice

Kodon Paspalum scrobiculatum

Kodon resembles mandua in its growth but the head is much more compact and the seed darker in colour It is grown only where the land is poor and is eaten by those who can get nothing better The crop is commonest in Bundelkhand on the higher fields and in the upland tract of Mirzapur in Oudh it is frequently grown mixed with rice in the poorer fields as it gives a good yield in moderately dry seasons when the rice suffers The tillage given is rough but weeding has to be carefully done the crop ripens in October and gives yields of up to 1 000 lbs per acre but a large proportion of this is husk, which is very thick and can be separated only with difficulty, hence the heads are left lying for some time after cutting to loosen the grain The crop is largely protected from birds, owing to the way the grain is set in the head it is said to suffer a good deal from insects but their nature has not been accurately determined it suffers also from either excess or serious defect of rain Speaking generally, wherever kodon is sown on a large area it means that the land is poor and probably the people are poor also

Sawan. Panicum frumentaceum.

Sawan grows to about the same size as mandua, but has broader leaves and an open feathery head Its grain is perhaps more popular for religious use than for food, but it ripens in such a short time sometimes within six weeks of sowing that it is widely grown where the people are poor and have very little reserve of food it is commonest in some parts of Rohilkhand, and in Bundelkhand and the eastern districts As the crop is valuable

mainly on account of its earliness, it is sown as soon as the rains break, sometimes in fact earlier, in the same way as broadcast rice: it does best on light soils, and the only attention it requires is careful weeding It is usually ripe before the end of August and yields up to about 800 lbs. per acre on good land, but probably less than half of this in the poorer soils of Bundelkhand.

Like most of the other small millets sawan does best when the rainfall is somewhat light and suffers severely from any excess

Kakun. Setariaitalica.

Kakun when young looks rather like a miniature juar plant, but its head is shaped like a knobby spike, which droops over as the weight of the grain increases. It is not a very common crop, but can be seen in most districts. It is sown early, often on highly manured land, and ripens in September giving about 400 lbs of grain to the acre. Differing from the other small millets it is a popular food, though like bajra it is considered to be heating Its greatest enemies are the birds as its grain is exposed

One other small millet may be briefly mentioned it is grown only in the south of Bundelkhand, where it is called kutki, and in Mirzapur, where it is known as mijhri. It is very little better than a wild grass, and is grown on the very poorest soils, yielding about 150 lbs. of grain to the acre

Autumn pulses.

The autumn pulses are arhar, urd (or mash), mung, moth, lobia and guar. As a general rule these crops are hardly ever grown alone, but are mixed with other kharif crops: arhar however is grown by itself in some of the submontane districts, and urd is frequently sown alone in Sitapur and Kheri. We have already noticed the great importance of these crops in maintaining the stock of

combined nitrogen in the soil while the produce is valuable food for both men and animals

Arhar Cajanus indicus

Arhar is quite different in appearance from the common field crops growing to a thick bush with a woody stem, the leaves are narrow and of a darker green than most crops and the roots go a great way into the soil The crop is usually sown with juar bajra and cotton, it germinates along with these but it grows much more slowly than the large millets and when they are cut the arhar plants are short and slender They are then left on the ground with no further tillage as the plants are high above weeds and their deep roots enable them to draw water from a long way down and thus render irrigation unnecessary The plant flowers in the cold weather the flowers being bright yellow and then pods form which contain the seeds arranged in a row When ripe in March or April the plants have to be cut down with a hoe being too strong for the ordinary sickle the leaves and pods are stripped off and the grain is either trodden or beaten out and winnowed in the usual way The yield has usually been returned at from 400 to 600 lbs per acre but this is probably much below the truth, it tends to vary inversely with the outturn of the millet, when the latter has been a heavy crop, the arhar is usually poor and *vice versa* A striking instance of this was seen in 1896 7 when the millets had been very poor in some parts of Oudh, the arhar in that year flowered early and after the pods had been gathered it flowered a second time and gave a further crop

When arhar is sown with cotton it is usually placed in lines about fifteen feet apart, it grows thick and high as cotton is a low growing plant and it is of particular value as a shelter the outturn from a cotton field is not however as great as from a millet field as the arhar plants are far fewer in number It may be added that arhar should never

be sown with the finer kinds of cotton as these are spreading plants and their growth is much affected by any crowding

Arhar seems to survive any deficiency of rain short of an absolute drought and depends little on cold weather rain while nothing short of regular floods seem to injure it seriously but it has dangers of its own The greatest is frost to which the plant is more liable than any other of our field crops a single ground frost may destroy the entire crop The damage is always greatest on the light soils and is unavoidable though occasionally the crop may be saved by prompt irrigation. The caterpillar known usually as *chedda* does a good deal of harm in some seasons, boring into the pods and eating the young seeds. In some parts of India the crop suffers very severely from a fungus known as wilt disease This disease has recently caused much loss in Dehra Dun but has not been recorded in the plains

Arhar is comparatively little sown in the western districts where the danger from frost is greatest though even there it is often to be seen in the cotton fields but it is almost universal in the rest of the provinces There are some varieties one of which ripens sufficiently early to escape frost and can be sown alone or with cotton but not with juar

The dry leaves and pods make most nourishing food for cattle and the stalks are put to a great variety of uses the chief of which is lining temporary wells For this purpose the stalks are bound into a long rope which is coiled round the inside of the well

Urd or mash Phaseolus radiatus

This and the remaining kharif pulses are quite different in appearance from arhar Urd is a low creeping plant which forms a dense mat over the ground and as in other pulses the seed is arranged in pods Urd is very

commonly sown alone in North Oudh and when so sown it need not be put into the ground till the other kharif has been sown and is often not sown till late in August but it is most commonly mixed with the large millets and arhar, and then it is sown along with them. Once sown it gets no further attention till it is ready for harvesting there is an early variety which is ripe in August or September, but most of what is sown ripens in November, when the plants are pulled up or cut, carried to the threshing floor and the grain trodden out When sown alone it yields about 400lbs of grain and the bhusa or trodden straw is very rich fodder The outturn of the mixed crop depends largely on what has happened to the millets, if they have failed the urd may be excellent while if they are good it is usually poor This is probably one reason why it does relatively well in a dry September, but on the other hand excessive rain in that month is fatal to it in such seasons the plants suffer greatly from some kind of fungus on the leaves, while the pods are ravaged by caterpillars, and if the rain comes while the plants are flowering fertilisation is prevented and no grain forms

Mung Phaseolus mungo

Mung is exceedingly like urd in the field it has leaves of a darker green while the pods are longer and thinner, the seed however is smaller There are three varieties of which the commonest is that with green seeds the others being black and yellow There does not seem to be any early ripening variety but with this exception all that has been said of urd applies equally to mung

Moth Phaseolus aconitifolius

Moth is another plant of the same type but it can be easily recognised by the outlines of its leaves which are broken into numerous points while those of mung and urd have an even outline It is either grown by itself on the

very worst land or mixed with bajra on inferior sandy soils It is cultivated roughly, and gives a relatively heavy outturn sometimes over 600lbs to the acre if things are favourable, but like the other pulses it is very liable to injury from rain at flowering time The grain is eaten, but it is a very unpopular food, and most of it is probably given to cattle which thrive on it

Lubia. *Vigna catiang.*

The leaves of lubia are very like those of urd or mung, but are smoother, while the plant climbs when it can rather than creep, and the flowers are a reddish purple It is very rarely sown alone, but is mixed in millet fields like the other pulses and may often be seen climbing up the stems of the millets it does best in fairly dry seasons, and yields about the same quantity of grain as urd, the grain however is by no means so much relished

There is a variety of this crop with very long pods which is grown as a vegetable, the pods have a superficial resemblance to French beans With this may be mention ed the plant known as sem a long climbing pulse with flowers of varying colours, which may often be seen along the borders of millet fields and especially climbing on the castor plants It is used as a vegetable

Guar. *Cyamopsis psoralioides.*

This pulse too is occasionally grown as a vegetable, but its principal use is for cattle food Differing from urd &c, it grows upright It is sown when the rains break and ripens in October, giving about 800lbs of grain to the acre It is also sometimes cut for fodder while green, and may be grown along with juar for this purpose Its growth is almost confined to the western districts

Miscellaneous food crops

The miscellaneous food crops grown in the kharif season

are not of great importance, the following may be mentioned —

Sweet potato Ipomaea batatas. Vernacular, Shakkarqand.

This is a low creeping plant which covers the ground thickly with a mass of smooth leaves It is not grown for its seed but is one of the plants which store up food in their roots for a later period of growth Cut pieces of the root are planted in the ground early in the rains each of them starts a new plant and by December these have formed large thick roots which are dug up for food These are eaten as a vegetable often curried and are also used in preparing various sweetmeats The leaves are good food for cattle

***Ramdana* Amaranthus candatus.**

This plant, which is grown largely in the hills is also to be seen in many parts of the plains growing along with low pulses and occasionally other crops The whole upper part of the plant is of a deep red colour, rising to a large plume, which contains the seeds This crop is sown in the rains and ripens in October, it is of no particular importance as a food supply in the plains, but its magnificent colour renders even a few plants a conspicuous object in a field The grain is valued chiefly for ceremonial purposes

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CHAPTER XVIII THE PRINCIPAL CROPS — KHARIF NON FOOD CROPS

Among the kharif crops which are not used for food only six are of sufficient importance to require separate notice three of these are oilseeds and the remainder fibres

Til *Sesamum indicum*.

The til plant is one of the chief sources of the oil used so extensively by the people It is an erect plant from three to four feet high and the oil is obtained from the

seeds which are found in great numbers in the capsules at the upper end of the stem Til is very commonly sown along with juar bajra and cotton being sometimes broad casted along with the other crop and sometimes sown separately in lines through them and especially round the borders of the fields It ripens in O tober or November when the plants are cut with a sickle and allowed to dry in bundles They are then beaten on the ground when the eed falls out of the capsules The stalks are used for fuel

Til is grown by itself in some of the submontane dis tricts and very largely in Bundelkhand In this case it is usually sown on poor land with harried and imperfect till age and yields about 300 lbs of seed to the acre it can be sown as late as August

Th e great danger to til is ra n at flowering time and hence heavy storms at the end of the rains may result in the almost entire failure of the crop

The oil is extracted from the seeds by pressing in a simple wooden mill worked by a bullock it is almost universally used with food and for cooking and to a less extent in the toilet and for burning The residue of the seeds after the oil has been pressed out is known as oilcake and is a very valuable food for cattle—indeed it is occa sionally eaten by the poor

There is considerable trade in this oil seed which is known in European markets as sesamum or gingelly the latter term being the name current for the crop in South India

There are two varieties one with black the other with white seeds the oil of the latter is preferred for use with food

Castor Ricinus communis Vernacular
Arend of rendi

Castor is a tall and quick growing plant growing almost to the size of a small tree in one season its leaves are

large and have a marked tinge of light blue on the stalks and under surface the seed is borne in a group of spiked clusters at the crown of the plant It is very rarely sown alone though small plots are occasionally to be seen close to villages or sometimes on river banks, but it is most commonly grown as a sort of hedge to fields of sugarcane, cotton and other kharif crops, sometimes also on banks along the roads and paths It does best where it has a great deal of space and is in no danger of water logging The seeds are either sown behind the plough about 18 inches apart or planted singly by hand about the beginning of the rains or even a little before The crop ripens about March when the capsules are gathered and either allowed to dry in the sun or buried in the ground till they rot Then the seeds are taken out heated for a short while crushed in a mortar and then boiled in water the oil is skimmed off as it comes to the surface of the water It is used for lighting and to less extent for oiling cart wheels and the other simple machinery in use among the people

Ground nuts Arachis hypogen *Vern* Mungphuli, Mungphuli.

This crop which is one of the staples of Southern India has recently been introduced into the provinces by the Agricultural department It is a leguminous plant that is it is of the same class as the pulses but differs from them in forming its seed under ground The plant is small and bushy and some varieties throw out trailing stems along the ground The flower is yellow When the flower falls the stock bends over and enters the ground where the seed forms as a nut

The crop does best on light well-drained loam, it is particularly sensitive to water logging The tillage is similar to that for maize, and the crop can be sown in May with irrigation Early sowing is desirable, and one watering may be necessary if the rains cease early The

seed may be either placed in holes by hand or sown in drills behind the plough, careful weeding is required until the crop covers the ground, and it is important that the surface soil should not be hard when the plant is flowering The nuts are usually ready for digging in November or December, and a yield of about 1,600 lbs per acre may be expected The nuts are sold locally for food while there is a very large export to Europe for oil pressing from those provinces where the crop is grown on a large scale

The crop is liable to damage by pigs and rats as well as by water logging no serious insect pests or fungoid diseases have yet appeared in these provinces

There are two main types one has large nuts and is called mungphala the other (mungphali) has smaller nuts and grows more erect The former type appears to do best in the province

The crop is at present grown only on a small scale, but it will probably increase rapidly in popularity At present prices it pays very well and it leaves the land clean and in excellent condition for the next crop The chief drawback is the cost of digging up the nuts, and mainly for this reason the crop appeals to small cultivators who are not afraid of work

Cotton. Gossypium neglectum. Vernacular, Bari, ban, kapas

Cotton is one of the important crops of the provinces, forming as it does the raw material for the clothing of almost the whole population. It is rather a bushy plant growing about four feet high with broad leaves deeply indented The flower is mainly yellow* and the seed when it forms is enclosed in a mass of soft white fibre, which is the chief product of the crop Cotton should be sown as

*A variety with white flowers which is grown in parts of the Aligarh district gives a larger yield of fibre than the ordinary type with yellow flowers

early as possible after the beginning of the rains in fact there is no doubt that the growing season in these provinces is too short for the plant to reach perfection and the practice of sowing it in June or even in May with the aid of canal water has developed very rapidly in recent years

North of the Jumna the crop is usually grown on fairly good land and often with manure The soil should be loam light rather than heavy and so placed as to be out of the reach of stagnant water it is usually well tilled and weeded whenever necessary but when sown with irrigation the tillage is often rudimentary as has been noticed above arhar and til are frequently grown in the same field Cotton requires a season of light rain and in fact there is a saying that it does best in a half famine The seed forms in closed pods which are spoken of as bolls these begin to open about October when the seed is ripe and the seed with the fibre adhering to it is gathered by hand as the bolls open The field is picked over every third or fourth day if necessary and the cotton gathered as it appears picking may go on till January in favourable years

The next step is to separate the seed from the fibre this was formerly done by passing the fibre between two wooden rollers in a little machine called charkhi but an increasing amount is separated by the steam ginning mills which have sprung up over most of the cotton districts. The seed is a valuable food for cattle it contains a good deal of oil which can be extracted by suitable machinery and is useful for cooking but the industry is not yet established in the provinces

As has been said above cotton does best in seasons of light rainfall Any accumulation of water in the fields is ruinous to the crop and much damage is sure to result from rain late in the season A variety of insects also injure the product by feeding on the plant and specially on the seed, when they do this the fibre becomes so

weakened and discoloured as to be almost unsaleable Caterpillars also may do a great deal of harm by stripping the plant of leaves, and finally frost often kills off the plants, or at any rate puts a stop to the production of seed and fibre a fortnight before the time when the picking would otherwise end.

Cotton is grown mainly in the west of the provinces, where the rainfall is less than in the east, and where a wet September is rare. It is also very largely grown in Bundelkhand, but it is rare in most of Oudh and in the eastern districts, where the heavier rainfall and the prevailing clay soils are not adapted to the plant In a few places in the east a distinct variety of cotton, known as narma, is grown. This gives its produce only in the hot weather when it has occupied the ground for ten or eleven months, and it is not a profitable crop and is slowly disappearing

The yield of fibre probably varies from 150 to 200 lbs. to the acre, but the crop is distinctly speculative, and much higher and much lower yields are probably common, while the length of the picking season makes it very difficult to ascertain the outturn with any approach to accuracy The great defects of the cotton grown in these provinces are the shortness and coarseness of the fibre, which make it unsuitable for spinning any but the coarsest yarns Cotton of medium quality can be grown from seed imported from America and properly acclimatised, but the trade has not yet developed to a point where better cotton will pay the small grower It is probable also that a better cotton will eventually be produced from the indigenous strains, a subject which is engaging the attention of the Agricultural department

Sann-hemp. Crotolaria juncea, Vernacular, Sann, sanai.

This plant must not be confused with the true hemp which is known in vernacular as bhang, and is cultivated

in the hills and rarely in the plains for the intoxicating drugs which it produces Sann hemp grows in long slender stems from four to eight feet high with scanty leaves and small bright yellow flowers It does well on poor soils provided they are not waterlogged Most usually it is sown as a border to cotton and juar fields but in an increasing degree it is sown by itself, in this case the seeds are sown very close together so that the plants are forced to grow to a considerable height it smothers all weeds by the rapidity of its growth so much so that when a field has got full of weeds it is good practice to take a crop of sann off it in order to clean it Some plants are left standing until November in order that the seed may mature but to get the best fibre the crop is cut down while in flower the leafy top are given to cattle while the long stems are made into bundles and soaked in a waterhole to loosen the fibres which grow round the wood of the stems When sufficiently loose the stems are beaten on the surface of the water and the fibres come off easily When it has been grown in small patches or as a field border the fibre is kept by the cultivator for his own use and is made into well ropes string and so on But a considerable trade with Europe has arisen in this fibre during recent years and large quantities are exported from Rohilkhand Benares South Oudh and Bundelkhand. The growth of this crop fits in well with sugarcane, it is one of those which supply combined nitrogen to the soil so that when it is grown the land is left free from weeds and in good condition for the cane

The outturn is about 600 to 700 lbs of cleaned fibre to the acre The crop seems to be wonderfully free from risk

of injury provided it can be sown in time and the weather is not altogether abnormal

Roselle hemp. Hibiscus cannabinus Vernacular Patsan

This crop is hardly ever grown alone but is sown as a border with various kharif crops It is quite different in appearance from sann hemp shorter and bushier with large, open, red and yellow flowers There seem to be no points of special interest connected with its cultivation when ripe the plants are cut or pulled soaked in water, and the bark pulled off by hand The fibre so obtained is softer whiter, and silkier than that of sann hemp but is much weaker and sells for much less It is grown almost entirely for domestic use, and is used for making coarse cloth or sacking, and for the finer qualities of string the best qualities come from Meerut and from the north of Oudh

CHAPTER XIX —THE PRINCIPAL CROPS—RABI FOOD CROPS

Wheat Triticum sativum Vernacular, Gehun

Wheat is the great rabi crop of the provinces It is too well known to need description but we may just mention that almost all the varieties common in the provinces have a fair-sized beard ' as the projections on the tips of the ears are called It is sown in the latter part of October in any loam and in lighter clays and heavier sands Usually the land has borne no crop in the kharif, but the practice of sowing it after maize appears to be spreading The crop needs very thorough tillage if it is to be remunerative, and ploughing for it usually begins in August as soon as the kharif has been got into the ground Ploughing in the previous hot weather gives an exceedingly good result when it can be carried out Ploughing continues in the intervals of the rains and usually eight or more

ploughings are given when the rain is over the manure is spread on the field and ploughed in, then tillage goes on the plough and the clod crusher being used until the seed bed is just right in point of moisture and temperature When this point has been attained the seed is usually sown behind the plough or in the west through a drill attached to the plough If the land is wet, the clod crusher is not used after sowing but in ordinary seasons its use is general so that moisture for the seed bed is brought up from below The next step is to throw up small ridges in the field, dividing it into squares to facilitate irrigation The first watering is usually given in December after which the field is weeded if necessary, a second watering follows in January and usually a third in February unless rain has fallen in the meantime The crop ripens in March or April and is cut by sickles and carried to the threshing floor where the grain is trodden out by cattle in the usual way

The first great danger to the wheat grower is that by the time the temperature has fallen sufficiently for sowing the ground may be too dry The seed is expensive and a large quantity (80 to 120 lbs to the acre) is sown, so that the loss of the seed cannot be risked. It is therefore sometimes necessary to water the field before sowing, this watering (which is usually called paleo) is easily done in the canal districts but costs much labour and takes much time where the water has to be raised from wells after a dry September, however, it is done as a matter of course The next danger, a heavy fall of rain in October, depends for its effect very much on the exact time of its occurrence If the land is nearly ready for sowing, the loss may be serious for the seed bed is compacted by the force of the rain and there is not time to prepare it properly again, while if rain falls just after the seed has been sown, as happened in some places in 1894, the seed may rot and

resowing may be necessary Once the plants have made a start the great danger is wet and cloudy weather during January and February the great majority of the wheat is sown on land that can be irrigated, and though light falls of rain, followed immediately by bright sun, are of great value as saving the labour of one or more waterings, any prolongation of the damp weather at once gives rise to the greatest anxiety since it is almost sure to be followed by the spread of rust We have already indicated the ruinous effect which this fungus may have, and we need only add that on the experience of recent years the injury is most to be feared in Bundelkhand and in Oudh It is hardly too much to say that wheat-growers who have plenty of water at their disposal actually prefer a perfectly dry cold weather, and there is no doubt that the highest outturns have been obtained in years of this character

When high west winds set in early in February the outturn of wheat is reduced, as the grain in the ear tends to dry prematurely and shrivel

The fungi which are known as smut and bunt and give so much trouble in many countries are very rare in these provinces, but on the other hand there is occasional injury from the disease known as sehwan when the grain is found to be infested with minute worms

The outturn of irrigated wheat averages 1,200 lbs or more to the acre, and only about five per cent of the weight is lost in grinding it into ata or meal The best wheat comes from the western districts especially Meerut and Muzaffarnagar, and the quality on the whole decreases as one goes east The cultivators in the eastern districts are in many cases too poor to undertake the cultivation of this crop and the area under it is proportionately less there than elsewhere Ata is the food of the upper classes, and the lower classes eat it when they can get it In a

good season the province produces much more wheat than it consumes and the balance is exported to Europe,

Rape (sarson) is usually grown in the field with wheat and harvested separately, there are two common mixtures, wheat barley and wheat-gram Wheat barley is called gujai, and is frequently sown in the eastern half of the provinces the two grains are harvested and threshed together and ground together as flour Wheat gram is more common in the western districts, and is the usual crop in Bundelkhand, in the latter case water for irrigation is not usually available, and though the soils are very retentive of moisture it is risky to sow wheat entirely by itself It is therefore usually mixed with gram, which often gives a good crop when the wheat is of little value The amount of wheat grown in Bundelkhand, whether alone or mixed with gram fell off largely at the end of the last century, owing in great part to the loss from rust in 1894 and 1895, but the last few years have seen a distinct recovery

The varieties of wheat are almost innumerable the main distinction between them is that of the hard and soft grains, the former when ripe are almost transparent, while the latter are opaque and much easier to cut The hard wheat contains a higher proportion of nitrogenous matter, and is therefore the more nourishing of the two, it is commonly preferred for consumption in the provinces, though the flour of soft wheat is used on ceremonial occasions Another distinction between varieties is the colour of the grain, which varies from almost white to dark brown or red The soft white wheat is usually called dudia red wheat is lallia, while beardless wheats are mundia In Bundelkhand where most of the wheat is red, the term pissi is usually applied to soft wheat and kathia to hard, but the two kinds are often mixed in one field, and this is true in most other parts of the provinces where several varieties are sown mixed

Hitherto the export trade has given the best prices for the soft white wheat grown in the upper duab The consuming markets would probably pay higher prices for a strong wheat with good milling qualities, and these can be produced in some parts of the provinces provided the tillage is sufficiently good

Barley Hordeum vulgare Vernacular, Jau

While growing barley has a strong general resemblance to wheat, but the arrangement of the grain on the ear is altogether distinct, and there is a kind of frill at the point where the leaf separates from the stem that makes it easy to distinguish it in the early stages It is grown at the same season as wheat and generally in the same way, but with less labour and expense Thus it gets fewer ploughings, less manure, less water (being much more frequently grown without irrigation), and it very commonly follows a kharif crop in the same year * Weeding, too, is much more rarely done and the crop is generally found growing on poorer soils than wheat, thus in all these respects it is a second-class crop Accordingly it is most commonly grown in the Benares division and least in the wheat districts of the west The outturn of grain is rather higher than in the case of wheat, but a large proportion of this is the husk, which adheres to the grain when being threshed, and has to be removed in grinding

Irrigation being rarer, barley is much more dependent than wheat on winter rains, and if these fail entirely the outturn may be very poor Excessive rain may involve very serious injury from rust

Barley is not very much sown alone we have seen above that it is sometimes mixed with wheat, but most commonly it is grown along with gram or peas, or both,

* The practice of taking a crop of barley and peas after cotton is making rapid headway in the west of the provinces The cotton is taken off the field about the end of November, and the land ploughed hurriedly after irrigation

when the mixture is known as bejhar, or bijhra, as well as by other local names The produce of the mixed crop supplies a great portion of the food of the poorer classes

In the last few years a demand for Indian barley has arisen in Europe, and a considerable export trade is deve loping, which may lead to an increase in the area under the unmixed crop, and also to a rise in price compared with other grains

Oats Avena sativa Vernacular, Jai

Oats belong to the same class of crops as wheat and barley, but unlike them are a recent introduction to the provinces, and are grown only in a few localities, the grain is not eaten by the people to any extent, but is given to horses, and the cultivation is of importance only in a few *parts of Meerut and Rohilkhand The seed will germinate* in a colder and moister seed bed than wheat, and the crop can sometimes be sown with good results as late as Decem ber on the cold heavy soils that have been too wet to sow anything in October or early November If the crop is irrigated copiously, it can be cut once or twice for fodder, and finally left to mature its grain, but in these circum stances the produce of grain is greatly reduced When grown for grain alone the produce may be as much as 1,500 lbs per acre The tillage given is generally similar to that for barley

Gram Cicer arietinum Vernacular, Chana

Gram is the principal rabi pulse of all parts of the pro vinces west of Allahabad It is a low growing feathery plant with small flowers, usually pink in colour, and holds its grain in small pods more or less globe shaped, not long and narrow like the kharif pulses or peas It appears to be suited by a warmer seed bed than either wheat or barley, and is always the first crop to be sown sowings often be gin in September and go on till the middle of October in ordinary years It is often sown by itself, and also mixed with wheat and barley, as has been already mentioned

The heavy soils suit it best, but in grows on almost all, and does not require a very fine seed bed in fact it may be seen growing fairly well among the heavy clods of rice fields that have merely been hurriedly broken up with the plough It is rarely irrigated except in very dry seasons, and in the Meerut division, weeding is seldom needed, but a common practice is to nip the tops of the young plants before they flower the result of which is to make the plants bushier, and it is believed to increase the quantity of grain. Harvesting and threshing are carried out in the same way as with wheat the outturn averages about 700 to 800 lbs, which may rise to 1 000 or even more

The gram crop is apt to suffer a good deal if anything occurs to interfere with the regular routine of sowings Thus in 1896 after an entirely dry September the people first concentrated their efforts on sowing wheat, and sowed the gram later, but by the time they did so the ground was too cold and the crop was poor from the first The lesson so learned has been appreciated and in more recent droughts the people have sown barley instead of gram almost wherever they could get the seed Again, when there is heavy rain in October the early sown gram may be destroyed, while the ground is so much chilled by the rain that what is sown later does not germinate properly Being unirrigated the crop depends very largely on a fall of rain in January but it is not an entire failure even if the whole season is dry Frost when the plants are in flower, does a great deal of harm and caterpillars may in damp years cause much loss both by eating the leaves and by boring into the pods and eating the grain It does not appear to be affected seriously by any fungus

There are several varieties differing mostly in the size and colour of the gram one of these, known as Cabuli, has a large white seed and is a very handsome plant, but it has not proved so suitable for these provinces as the ordinary kinds, the produce of grain being considerably less

Peas Pisum arvense and Pisum sativum Vernacular, Mattar

Two species of field peas are grown to some extent all over the provinces but mainly in the districts east of Allahabad Like gram they are sown early by preference on the heavier and damper soils and often mixed with barley but apparently a cooler seed bed is desirable as peas are sometimes substituted for gram when early October has been wet this would also explain why peas take the place of gram in the agriculture of the eastern districts which usually get more rain late in the season The cultivation is generally similar to that of gram but irrigation is much more common The outturn is higher than that of gram rising to 1 100 or 1 200 lbs to the acre.

Peas suffer greatly from frost but in the eastern districts where they are most largely grown the danger of this is much less than further west They also suffer from the bahadura and other caterpillars In the east peas or mixed peas and barley are the first crops to ripen and are often harvested at the earliest possible moment in February when the stock of kharif food is already beginning to run low Near large towns the pods are sometimes gathered while green and sent into the vegetable market to be sold as garden peas when this is done the plants are grazed off by cattle

Lentil Ervum lens Vernacular, Masur

This is an inferior pulse rather similar in appearance to gram but not so bushy and with smaller and narrower leaves and a purplish flower It does best in low lying damp clays and is found most commonly in the tarai and submontane tracts It gets very little tillage being often sown in rice fields while the rice is still standing it is practically never manured and seldom irrigated and the outturn is little over half that of peas

Kasari Lathyrus sativus

This is the lowest of all the rabi pulses It is grown only where the people are poorest, that is to say in the eastern districts and parts of Bundelkhand and in them only on the worst land such as wet clay rice fields, and tank bottoms It has thin leaves ending in tendrils, and climbs when there is anything to climb on the flower is pink and blue the seeds which are like flattened peas are borne in short narrow pods The tillage is of the rough est, and manuring or irrigation is apparently unknown

The grain is eaten by the poorest classes it has been found to contain some drug that produces paralysis if consumed in large quantities, and wherever it has suddenly come into general use on the failure of other crops epidemics of paralysis have been observed to follow

Potatoes Solanum tuberosum Vernacular, Alu

The potato appears to be a fairly recent introduction into the provinces it is a common crop in the hills in the plains it is grown mainly round the larger towns but is spreading to the small towns and villages wherever there is an assured supply of water and manure The land gets thorough tillage usually being dug over with the phaora as well as ploughed frequently and very heavy dressings of manure are applied often in the form of poudrette The potatoes are planted in ridges between which water is allowed to flow at intervals of a week or ten days from November to January and the crop is usually ripe by February when the roots are dug No crop seems to respond more directly to heavy dressings of manure and ten tons or even more of roots may be taken off an acre but a cultivator has to be fairly prosperous to afford enough manure to make anything like this outturn possible and probably six tons is a good crop in ordinary circumstances

feet, and has small but conspicuous yellow flowers, these are succeeded by long green pods which contain the seed The varieties spoken of as sarson are very seldom grown alone but all over the provinces are to be seen in the fields of wheat, barley, and gram where they are sown either broadcast with the other crops or in lines through them The plants usually grow quicker than the wheat and get ahead of it if they grow so rank as to smother the wheat or if there is a scarcity of fodder, some of them are pulled up while green and given to cattle as fodder, the rest are left until the pods are ripe when the plants are gathered and the seed trodden out in the usual way Sarson ripens some time before the other crops with which it is sown.

The varieties known as lahi are usually shorter in growth than sarson but otherwise resemble it, they are very little grown except in the submontane districts, where they are sown by themselves in October and ripen usually in February The outturn in this case is about 500 to 600 lbs to the acre

The great danger is damp cloudy weather while the crop is growing as the small green aphis known as mahun spreads with enormous rapidity in such weather, and sucks the sap out of the plants This danger makes rape a speculative crop to sow by itself, probably the pest could be controlled by spraying and landholders should experiment in this direction under the guidance of the Agricultural department, but the practice cannot be recommended for fields where the crop is subsidiary to wheat or barley

Rape-seed is one of the great articles of export of the provinces but much of the produce is consumed locally in this case the oil is pressed by the teli as in the case of til, and is in great demand for cooking, and also for burning The cake is a valuable food for cattle.

Linseed. Linum usitatissimum Vernacular, Alsi.

This plant is largely grown in Europe for its fibre which is known as flax, but in India it is grown only for seed the European type of plant is a single long stem while the Indian plant has a number of short branched stems, and consequently bears more seed but shorter and weaker fibre The English type of flax can be grown in parts of the country, but there is no local market for it and fibre is never in practice extracted from the country plant Experiments are now in progress which may result in the establishment of a profitable trade in fibre

The plant is distinguished by its bright blue flower, which may be seen growing round gram and other rabi fields in many parts of the provinces It does best in heavy clay soils and is grown alone to a considerable extent in the black soils of Bundelkhand and in the rice districts, elsewhere it is sown as a border or in lines with other crops In Bundelkhand it is cultivated with some care getting three or four ploughings, but in the rice districts the seed is often scattered on the damp rice land and ploughed in roughly Irrigation is rarely given, and the plant needs no attention till it is ripe, when it is pulled up and the seeds beaten out of it The oil is pressed out of them in the usual way, and the cake is an excellent cattle food and is occasionally eaten by the poor About 500 to 600 lbs of seed are got from an acre when the plant is grown by itself A great deal of the seed produced in the provinces is exported to Europe

Linseed suffers very heavily from a fungus when the season is damp and cloudy the fungus has a general resemblance to rust in wheat and appears to thrive under the same conditions, it is one of the plagues of Bundelkhand that two of its few rabi staples are liable to injury from a single abnormality in the weather

Duan Eruca sativa

This is a medium sized plant with long leaves and yellowish flowers, which are followed by a row of short pods or capsules running along the stem of the plant and containing the seeds It is grown most commonly in the west of the provinces, but is rarely sown alone, it is usually sown as a border or mixture with barley and gram, and is sometimes sown roughly among the stalks of a cotton field The seed ripen ordinarily in March or early April and the oil is extracted from them in the usual way The stalks and leaves of the dry plant are of no use but if cut while green they can be used as fodder

Poppy. Papaver somniferum Vernacular, Posta.

The different varieties of poppy grown for the drug known as opium which they produce are all distinguished by their large white flower red or purple flowered varieties are grown in Central India but they do not suit the climate of these provinces No one can grow poppy without a licence from Government, and the licencees are bound to deliver the whole produce to the Government agency They are able to get loans on favourable terms to meet the cost of growing the crop which is in consequence very popular with them, provided they feel sure of good treatment from the subordinate officials of the department

Poppy requires a great deal of labour for its cultivation, it is usually sown in heavy loams or light clays and in rich manured land, which is ploughed as often as time allows. The seed is sown rather later than the ordinary rabi crops, and a watering before sowing is very often necessary When the plants come up a top-dressing of saltpetre or powdered dung and ashes is often given while it is a great advantage if the field can be watered from a well near a village site containing nitrates which have come into it out of the soil Frequent light waterings are

necessary, sometimes as often as once a fortnight, and the field must be kept quite free from weeds Growth is slow until February, after which it is very rapid, and as the petals begin to fall from the flowers they are collected and pressed into cakes, which are used for packing the opium After the petals have fallen the seed capsules swell up and the drug begins to form inside them, in order to collect it small scratches are made in the capsules with an instrument like a comb, this is done in the evening, and by the next morning some gummy juice is found to have collected where the capsule was cut this is the opium, and it is carefully scraped off and stored Each capsule is lanced several times before all the opium has been got out of it, and considering the large number of plants in a field it is obvious that this work is very laborious, while it demands a delicate touch, which can be acquired only by practice When nothing more can be got out of the capsules, they are cut off and the seeds they contain sold for oil manufacture, while the capsules themselves are bought by druggists for use as poultices or in fomentations Much of the seed is exported to Europe, where there is a demand for the oil

The outturn of the crude opium is believed to be about 20 lbs to the acre, all of this should be handed over to the Government agency at whatever price has been fixed, but it is only natural that the cultivator should keep a small supply of the drug for himself and his friends, and he is generally suspected of doing so

Caterpillars occasionally do a good deal of harm to the young plant by eating off the leaves it does not seem to be seriously affected by fungus, but the formation of the drug is very much dependent on the weather, and an east wind with damp air late in the season results in very serious loss

Tobacco Vernacular, Tambaku or Surthi

There are two species of tobacco grown in the province The commonest is *Nicotiana tavacum* or *desi tambaku* a tall shrub growing from four to six feet high with enormous smooth pointed leaves and pinkish flowers the other *Nicotiana rustica* or *Calcutta tambaku* is a lower plant with branching stems rounded crumpled leaves and pale yellow flowers Both alike are grown only in the most heavily manured fields and especially where the well water obtains nitrates As a rule the seedlings are raised in nurseries and planted out during October when the crop ripens in February in other cases the seedlings are planted out in February and the crop harvested in May In either case the soil is thoroughly tilled usually with the phaora and the seedlings planted out while it is moist The plants need a great quantity of water and irrigation may have to be done as often as once a fortnight the land has to be carefully weeded and all buds are picked off the plants as they form and the leaves thinned where they are too numerous When the leaves are ripe they are picked and left on the ground to wither then they are piled in a heap and left with an occasional sprinkling of water In this state they ferment and after a month or so they become pliable and are twisted into ropes for sale The process of fermentation is the work of very minute living beings and it is largely by attention at this stage that high class tobacco is produced in other countries in these provinces the fermentation appears to be left to chance but the product obtained is suitable to the tastes of the people

Tobacco planted out early may be seriously injured by the slightest touch of frost while that planted later is liable to be ruined by a hailstorm it is not much injured by insects or fungus in these provinces

and heavy dressings of manure are given The cane is propagated by means of cut pieces of the preceding crop, not by seed as the term is ordinarily used the cuttings are placed in furrows in the ground and covered in with the plough, and from this time the land requires frequent watering and hoeing until the rains break the hoeing being commonly done with a special tool resembling a small pickaxe, which breaks up the soil to a depth of six or eight inches, doubtless with the object of reducing evaporation as much as possible Once the rains have come, the crop is left to itself, though it must be watered again in long breaks or when the rains have ceased early It is usually ripe about December in the west and from January onwards in the east, in this instance the term "ripe" does not denote that seeds have formed, but that the plant has just reached the stage where the quantity of sugar in the juice is at a maximum If left standing after this point, the plant begins to use up the sugar again for its own nutrition, and some varieties occasionally send up a long feathery flower This happens to a much greater extent in some years than in others, and is commonly believed to cause a serious decrease in the yield of sugar the popular view has not however been so far confirmed by such experiments as have been carried out When ripe the canes are cut and stripped of their leaves, and the juice is pressed out and boiled down to sugar We need not describe these processes in detail, a full account of them would take up excessive space and the information is available elsewhere *

Cane is certainly a speculative crop It is fairly safe during the ordinary hot weather as provision has been made beforehand for its irrigation, but when the beginning of the rains is delayed and a period of intense hot weather sets in during June and July serious loss results, as the

* See 'The Sugar Industry in the United Provinces', by S Muhammad Hadi, published at the Allahabad Government Press

evaporation from the soil is so great that it is very difficult or even impossible to keep the land sufficiently moist Long breaks in the rains too do much harm the period from June to September is that during which the growth of the plant is greatest, and any hindrance to growth in those months cannot be recovered On the other hand cane can stand a considerable excess of water without suffering much injury, but where it has been sown in low lands without irrigation long continued floods may destroy it We have already mentioned the cane borers and cane hoppers which may do so much harm, and the still more serious rind fungus, caterpillars also injure the young plants, and jackals have to be watched for when the cane is mature Pigs are also a source of danger white ants too are ruinous to the cuttings when first placed in the ground

The outturn of the crop may be roughly put at from 25 to 35 maunds of gur to the acre, gur being the commonest form of sugar produced it varies greatly with the kind of cane, with the season, and also with the skill of the cultivator, and it cannot be estimated with any degree of certainty from the look of the standing crop, for it often happens that large canes full of juice may have comparatively little sugar in them, while thin dry canes may be very rich The crop pays very well to a man who knows how to grow it and who, with his family, does as much of the work as possible, grown by hired labour or by an ignorant man it is usually an unprofitable venture

The number of varieties is very great, and many of them appear to be very much localised, that is to say, a variety that does admirably in one district may be almost a complete failure a little way off Most of the canes grown for sugar are thin reedy looking things, quite different from the thick juicy canes that are seen in other countries: where thick canes are grown in these provinces, sugar is very

rarely made from them nor would it pay to do so with the ordinary appliances They are in great demand as a fruit, these thick canes are known as paunda in contradistinction to the thin canes or nikh canes of an intermediate thickness, known as ganna are grown in parts of the western districts for their sugar Paunda is usually to be found in the rich garden land close to towns It is much more expensive to grow than the ordinary canes requiring more water and very much more manure but it is exceedingly profitable owing to the high price that is paid for the fruit

There is probably room for a considerable development of the sugar industry in the provinces progress must depend on the one hand on the adoption of better methods of manufacture and on the other hand on the growth of the best varieties and on improved methods of cultivation There is very little doubt that the potential yield of sugar can be very largely increased while it is quite certain that a much higher proportion of the potential yield can be recovered by the use of suitable machinery

Chehna *Panicum miliaceum*

Chehna is a small millet exceedingly like sawan and in fact it is called sawan in parts of Oudh where it is most largely grown but it is a distinct crop It is grown in Bundelkhand as a kharif crop but in the rest of the provinces it is sown in the period from February to April it is common in parts of Meerut and Agra but south-east Oudh is its great home It has to be watered constantly, and does much better with well water than when watered from the canal, in fact its whole existence may be summed up in the one word water It ripens inside of two months and is harvested like the other small millets giving a yield of from 400 to 500 lbs to the acre

The growth of this crop involves very heavy work on the bullocks that raise the water and on the cultivator

himself, at a season when even a bullock feels the heat severely, and its value lies in the fact that it brings in a fresh stock of food for his household. Thus the extent of its cultivation depends largely on the previous harvests where the crops have been good and the cultivator has something in hand he saves his labour and his cattle, but when his store is short, he sets to work to replenish it Consequently it is in a famine season that the crop is most grown after a serious loss of kharif and with a reduced rabi area, the people in south Oudh set to work and grow amazing crops of sawan all through the hot weather, and there is no doubt that the crop helps greatly to ease the pressure of scarcity In such seasons the price of seed rises to an abnormally high figure, and loans can often be given with advantage to enable the people to procure it

Melons.

Very many kinds of melons are grown in the hot weather the ordinary melon is known as kharhuza, while the water melon is called tarbuz. Many of them are grown in small patches of highly manured land where they can be constantly watered, but the most striking method of growing them is the use of the coarse sand of river beds Where the sand is entirely barren holes are made in it and filled with manure, in which the plants are sown, while if the sand is finer less manure is used in either case the wetness of the sand due to the neighbourhood of the river is the great point melons require an enormous quantity of water, and they get it in this way with a minimum of labour Melons grown in this way begin to ripen in April, and the crop continues till ended by a flood on the river, which submerges the ground. Water melons are sown rather earlier than the other kinds, and ripen in the beginning of the hot weather

The large number of plants allied to melons and known

generally as gourds or as cucumbers need not be described in detail they are sown and come into the market at varying seasons during the hot weather and rains, and add materially to the food supply The acreage under them extends largely in a famine year, and at such times they are commonly sown in maize fields, in order to get the earliest possible addition to the supply of food

Singhara. Trapa bispinnosa.

This is a water plant, growing in tanks and ponds with its roots in the soil and its leaves floating on the surface of the water The young plants are raised either from seed sown in the cold weather or from cuttings of plants that have survived from the previous harvest these have to be planted out under water and fixed to pegs driven in the mud. The leaves soon form a dense mat on the surface of the tank, and the cultivator goes round on a boat or raft and gathers the nuts as they ripen There is of course no tillage, but the plants while growing have to be watched very closely for the appearance of insects, and any that are seen must be picked off.

As a rule the crop is confined to small tanks and waterholes, but occasionally it is seen covering a large area in a jhil, with the "fields" marked out by bamboos standing out above the water in such cases the harvest gives employment to considerable numbers of labourers, and the nuts are sold wholesale, under the ordinary practice the cultivator carries his small bag of nuts to the nearest market, or sometimes retails them on the roadside

The nut is dark in colour and looks rather like a chest nut the kernel is eaten both cooked and raw, and it is also made into flour The cultivation is carried on almost entirely by kahars and similar castes, who are at home in the water, and they make a very fair profit out of it as the nut is in great demand

Carrots Daucus carota. Vernacular, Gajar.

The Indian carrot is different from that which is familiar to Europeans as a vegetable ,the root is dark coloured and is coarse and flavourless The seed is usually sown in September, and a large field of carrots is rare, odd corners of land and the waste patches near a well being most commonly used The root is ready for digging in about two months after sowing Carrots therefore like several other crops mentioned in this chapter form a great resource when the kharif has failed as small patches can be grown with irrigation and add to the food supply for the winter, the seed always rises to a very high price in a famine season as the stock is strictly limited and seed freshly imported from other countries is apt to be a failure Like all other crops which are grown for their roots, the tillage should be deep so as to give the roots space to grow to their full size and the land is usually dug with the phaora instead of being ploughed

Radish. Raphanus sativus Vernacular, Mull

Radishes are grown for their bulk, and may be anything up to a foot in length the seed is sown in August or September and the roots are ready for digging by October or a little later according to the season Depth of tillage is necessary to get them of their full size

This is another crop which comes in very usefully when the kharif is a failure but in this case also the supply of seed is quite inadequate in such years, and of course the seed of the diminutive European radish would be useless

Indigo. Indigofera tinctoria. Vernacular, Nil

Indigo is a shrubby plant with numerous small leaves which is grown almost entirely for the dye that can be obtained out of the leaves and stems It was at one time a most important crop, as this dye could be obtained only

on the bank of a pond, and hence forms a conspicuous object in the flat landscape The cuttings of the plant are put into the ground about March, and are covered with wet grass till they have made a start they have to be irrigated constantly and are manured with pounded oil-cake and tended with continuous care They last for some years, leaves being picked of from time to time for sale

Kachiana.

Finally, to complete this brief summary of the crops that are commonly grown, we must mention the numerous herbs and spices which are conveniently described as garden crops or kachiana Near most large villages a few patches of land are usually to be found where small plots of a great many crops are growing side by side, including pepper, turmeric, ginger onions, a large number of herbs used as green vegetables, and various plants that yield spices or drugs of one kind or another These patches of land are constantly manured and watered, and are never bare of crops the kachis or men of other castes in the same grade are exceedingly clever gardeners and raise all that the village requires And when they come within reach of a larger market, they accommodate themselves to it with considerable aptitude, thus the Lucknow gardeners have specialised in strawberries peas, and tomatoes The gardener of this type shrinks from no amount of minute labour, giving each individual plant just what it seems to need he never stints manure, and will pay almost any rent rather than leave his bit of land when he has got it into order Such a man prefers to start on a light well-drained loam, or even fairly consistent sand, but whatever land he has to work on is soon transformed by the amount of manure applied A detailed description of the crops he grows and the methods he follows would be of interest only to specialists

towns or for other similar purposes They also supply fuel to the people living in their neighbourhood and they could supply a very much wider area if it were not for the fact that the cost of conveying it to the cities raises the price to a prohibitive figure Thus most of the country depends for its fuel on dung supplemented where possible by the branches and loppings of the trees that grow singly on the field boundaries and on the uncultivated land these trees also supply most of the wood used in the construction of agricultural implements and in building houses in the villages, the great resource is the babul or kikar which springs up in odd corners all over the provinces

Fruit trees—Guava

The variety of fruit trees is not very great Of the quicker growing kinds the commonest is the guava which is grown in orchards and never reaches the size of a large tree Each tree is carefully watered and often manure is dug in round the roots and for a few years a very heavy crop of fruit is obtained annually As soon as the trees begin to give poor yields it is best to cut them down and plant new ones in their place

Oranges &c

A number of varieties of oranges limes and lemons are grown in orchards in much the same way the fruit of nearly all the local varieties is of poor quality judged by European standards and the art of pruning seems to be almost unknown This art consists in cutting away some of the branches of each tree so that the energy of the plant's growth may be concentrated on a comparatively small surface when properly done it adds greatly to the weight of fruit borne by the tree but it is an art that has to be learnt by practice

Mangoes

Of large fruit trees also the number of kinds is very small but one of them the mango is grown in almost

also injure the crop to a less extent Another danger is the occurrence of storms before the fruit is ripe, as much of it is blown off the tree The green fruit is, however, not wholly wasted, as it can be made into pickles or preserves, of which a great variety is known to the people

Mahua.

Next to the mango the mahua is the most important of the larger fruit trees It grows wild over large areas in the red soil tracts of Bundelkhand, while it is regularly planted in Oudh and the eastern districts It is rare west of Cawnpore probably because the young trees cannot stand frost It is raised from seed, and is usually to be found in the duab in the stiffer soils, sometimes on land that is almost usar It grows into a tall handsome tree but the growth is exceedingly slow and it does not fruit for many years Once started however it gives a very heavy yield of yellow waxy flowers, which fall off the tree in April and are readily eaten both raw and cooked, they are also used largely for distilling as by the action of a ferment the sugar which they contain is readily changed into alcohol, which also receives a curious flavour, popular with the people but exceedingly distasteful to strangers After the flowers have fallen, a green fruit is formed on the tree which is also eaten, and the seeds that it contains yield an oil that is largely used in cooking It is also one of the best of the vegetable oils for various industrial processes, such as soap-making

The mahua then is a tree of the utmost value to the country, supplying large stores of food, and sometimes in seasons when the ordinary crops have been very poor but it is little planted nowadays The reason for its neglect is not very easy to ascertain in some places it is known that the landholders object to its being planted because, under the customs prevailing in Oudh, a tenant who has trees is entitled to them as long as he remains in the village, and a

man will rarely leave the village while he has trees in it, thus a mahua plantation means that the family of its owner is settled in the village for two or three generations Another reason is doubtless the time that elapses before any return is obtained a man who plants a grove of mangoes hopes to gather their fruit, but a middle-aged man who plants mahuas hardly expects to see them flower in his lifetime The tree, however yields such a valuable supply of food for the poor that it should not be allowed to disappear, and a grove of it is a substantial addition to the value of a moderate estate so that its growth should certainly be fostered by all landholders who desire to improve the value of their property

Jack-fruit.

The only other fruit tree that adds materially to the food supply of large numbers of the people is the jack, or kathal It is a large tree with shining dark green leaves and produces a great weight of fruit the fruit is covered with a thick prickly skin and grows out from the main trunk or the branches a single fruit weighing several pounds The tree is seen at its best in fairly good soil in the damper districts in the east of the provinces in drier country it fruits much less heavily, and usually requires to be irrigated before flowering time, but where the soil suits it, it pays exceedingly well

Other fruit trees

We may also mention the ber, which is little more than a shrub, but is cultivated widely for its fruit and the jamun a medium sized ever green tree, which yields a small plum shaped fruit it is of special importance in that it can be grown in marshy land such as the khadir, where mangoes and mahuas will not thrive

Fuel trees—Babul.

The most important trees for timber or fuel are the babul dhak, nim, and shisham The babul springs up

spontaneously in many places where land is left uncultivated, and can easily be raised from seed sown broadcast wherever the land is not absolute usar or bhur It is a quick growing tree, reaching maturity inside twenty years, and it pays best to cut it down in from the tenth to the fifteenth year of its growth The seed is borne in long pods, which make good food for sheep and goats the bark is the main supply of tannin, a substance which is indispensible for preparing leather, and of which large quantities are consumed in the Cawnpore tanneries, the larger parts of the wood are the regular material for making ploughs and other agricultural implements, and the smaller parts make excellent fuel, either burnt as they are or made into charcoal Taken all round, then, it is a tree of the greatest value, specially suited for growing on waste patches of land, banks of tanks and like, and as it costs hardly anything to raise and gives an assured income, either in money or in fuel, it is a tree that should be constantly in the mind of the landholder or agent who is seeking to improve his estate

Dhak.

The dhak is a crooked growing tree with broad leaves (very commonly used as plates) and magnificent scarlet flowers, which appear in the beginning of the hot weather It is found mainly on heavy clay, and survives where not even the babul can live, after it has grown for some years the branches are cut and sold for fuel, the roots remain in the ground, and throw up a new set of branches, which are again cut when they have reached a fair size This process by which a tree yields a regular supply of wood without the expense of replanting is known as coppicing some trees will grow up again when so treated and others will not, and it is obvious that the point is of great importance in connection with fuel supply The wood of the dhak is of no value as timber, but it makes excellent fuel,

of course adds to the cost of the plantation by an amount that depends on the depth of the kankar, and it is always a question whether the extra expense will pay, but so much is certain that the plantation will not pay if it rests on a bed of kankar within a few feet of the surface

Care of young trees

Once the trees have been planted it is necessary to see that they get enough water, but not too much As a rule they are watered by hand when young and the surface soil round them kept loose by hoeing so that trees carefully looked after need never suffer from drought It is more difficult to avoid the risk of water logging, which kills off trees very rapidly in their young stages if the ground is low lying and apt to be flooded, the trees should be planted on wide low mounds, while if there is no risk of flooding they should be level with the surface of the ground, but in no case below it If flooding occurs the land should be drained as soon as practicable

Young trees have also to be protected against frost and cold winds this is most effectively done by wrapping them in thatching grass in December and keeping the grass in position till February The other great danger is grazing Cattle passing by a young tree will often destroy it with a single bite, but the harm they do is small compared with what can be done by goats, which feed on trees by preference to any other kind of food. Either then the whole plantation must be protected from animals, or each separate tree must be fenced in by thorns or a mud bank The best way of protecting trees differs from place to place, and it is usually wisest to see how the cultivators protect their trees and to imitate their methods as closely as possible.

Trees for fodder.

The fact that cattle will feed on trees shows that they may be of use as fodder, and in fact trees may be a valuable

resource in a fodder famine such famines occur so rarely that it would probably not pay individual landholders to grow trees simply to meet the contingency but the fact affords an additional reason for adopting the policy of growing fuel on every patch of waste land small or large on which any kind of tree will grow, and it is in the hope that landholders who read this book will insist on the adoption of this policy in their estates that we have devoted so much space to a subject more properly described as forestry than as agriculture

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